

Environmental Science Under Siege:
Fringe Science and the 104th Congress

A Report by
Rep. George E. Brown, Jr., Ranking Democratic Member
to
the Democratic Caucus of the Committee on Science
U.S. House of Representatives
October 23, 1996

This report is being submitted by the Hon. George E. Brown, Jr., Ranking Democratic Member, House Committee on Science, for the information of and use by the Democratic Members of the Committee on Science. The report has not been reviewed or approved by the Democratic Caucus of the Committee and may therefore not necessarily reflect the views of all Members of the Caucus.

Transmittal Letter

Committee on Science
U.S. House of Representatives
October 23, 1996

TO: Members, Democratic Caucus
Committee on Science
FROM: George E. Brown, Jr.
Ranking Democratic Member

During the 104th Congress, the Committee on Science launched a major initiative directed at the basic integrity of the science community. Three major hearings, entitled "Scientific Integrity and the Public Trust," were convened by the Energy and Environment Subcommittee to showcase allegations that science had been distorted to promote an environmentalist agenda. The hearings focused on alleged abuses in the science on stratospheric ozone depletion, global climate change, and the health risks posed by dioxin.

This series of hearings did not occur in a vacuum. The new Republican Congress promised as part of its "Contract with America" to fundamentally change the way environmental regulations would be promulgated. With a new majority, dominated by what has been characterized as an inexperienced and ideological freshman class, the Republicans launched an attack on the basic methods by which environmental regulations could be established. In fact, this attack spread to encompass almost all forms of regulation-including those designed to insure public health, protect the environment, and guarantee workplace safety.

This radical effort in the House went too far, even for a Republican-dominated Senate, and regulatory reform legislation died in the 104th Congress. However,

the two most prominent qualities of the effort to pass this legislation in the House were (1) the shameless use of industry lobbyists to draft the legislation and staff Committee mark-ups, and (2) the widespread reliance on anecdotal stories, usually apocryphal, of the stupid consequences of regulations or the weak scientific basis for regulation. Again and again, like a mantra, we heard calls for "sound science" from Members who had little or no experience of what science does and how it progresses.

This broader environment in the House set the context for the hearings in the Subcommittee on Energy and Environment. The Subcommittee effort was an extension of the themes of the regulatory reform debate and the line of criticism laid out by big industry lobbyists. Widely quoted scientific critics of environmental regulation were cited for the proposition that Federal researchers were merely wasting dollars on a politically driven agenda. But the hearings went beyond allegations of overzealous regulators. They implied that scientists themselves were part of a vast conspiracy with environmental regulators. The terms of the pact were that the scientists would exaggerate their certainty and consensus on environmental problems and the bureaucrats could use these statements, with help from their environmental activist allies, to push through ever more stringent regulations and ever greater funding for the researchers. Bureaucrats were funding science that justified their existence and scientists sold their integrity to the bureaucrats in exchange for steady funding.

At the conclusion of these hearings, I asked the Minority staff to prepare a comprehensive report on the very serious allegations made by the Majority and their witnesses. My intent was to examine in more depth the specific charges leveled against the scientific community and the involved Federal agencies, to ascertain whether or not these charges had merit, and to review the political and cultural factors that may have motivated these hearings. The staff produced case studies of the three Subcommittee hearings. I then synthesized those cases into basic themes or findings. My report follows with the staff case studies included in the appendix.

Reviewing the hearing record, the staff could find no credible evidence to support the claims that scientists distorted their research to serve political ends. In fact, the record shows that the science in question was carried out in the best tradition of objective, peer-reviewed science.

This report raises serious concerns regarding the approach to science and policymaking represented by the hearings themselves. Beyond the specific allegations of misconduct lurks a deep distrust of government-funded science and the scientific "establishment" represented by peer-review and the scientific assessment process. This distrust flies in the face of House Republican's oft-repeated affection for basic research and science.

Further, there seemed to be an assumption that Congressional hearings would be an appropriate forum for determining scientific "truth" and for resolving scientific disagreements. This was tied to a sometimes implicit, sometimes explicit, critique of publication of experimental methods and findings and peer review. By rejecting the time-tested tradition of scientific peer review and substituting an overtly political process for judging scientific truth, the Subcommittee hearings were an ominous portent for the future role of science in environmental policymaking.

The hearings also produced a clearer understanding of what some Members appeared to mean when they invoked the phrase "sound" science. Apparently, only some kinds of scientific knowledge qualify as "sound" science. Further, the Majority seems to equate sound science with absolute certainty regarding a particular problem. By this standard, a substance can only be regulated after we know with absolute certainty that the substance is harmful. That is an unrealistic and inappropriate standard. Absolute, final certainty is a rare commodity in science. When dealing with complex scientific issues, we need to recognize that there will always be a range of uncertainty surrounding any scientific claim of understanding. Science cannot easily provide definitive answers to complex, real-world problems; problems of this kind provoke probabilistic statements from scientists, not cast-in-stone truths.

Scientific uncertainty is a constant that politicians and policymakers must have the courage to deal with. Coming to terms with the reality of scientific uncertainty does not, in itself, solve the issue of whether a particular situation demands action. The decision to act or not to act in a specific case is a policy choice. Whether we act or not, we need to remain open to further scientific work that may confirm the wisdom of the policy choice or may demonstrate that it was unnecessary. Science may be able to guide policymakers, but it cannot relieve policymakers of the obligation to make tough policy choices, choices that require a difficult balancing of competing interests. The Majority's demand for absolute and incontrovertible truth prior to action is a choice to ignore science rather than be counseled by it and an abdication of the responsibility to use the best knowledge available at any given time to serve the common good.

The real debates facing us are not about scientific issues, but about fundamental policy differences which reflect honest disagreements about the values of various competing social goals. I hope that the 105th Congress will engage these real issues in a more substantive and productive way.

I commend this valuable report to the Members' attention.

GEORGE E. BROWN, JR.
Ranking Democratic Member

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Executive Summary

One of the major claims asserted throughout the 104th Congress was that many environmental regulations were not based on "sound science," but instead on scare-mongering and gross exaggerations of environmental problems. In 1995, the Subcommittee on Energy and Environment convened hearings on the science relating to stratospheric ozone depletion, global climate change, and health risks of dioxin exposure. The hearings focused on claims by conservative think tanks, high profile "skeptical" scientists, and industry groups that these environmental problems had been systematically exaggerated for the purpose of promoting a regulatory agenda, and that scientific information and views inconsistent with this political agenda had been routinely ignored and even suppressed.

As detailed in the staff report attached as an appendix to this report, the hearings failed to produce credible substantiation for any of these claims of scientific misconduct. On the contrary, the hearings showed science being conducted in an objective and apolitical manner, consistent with the traditional norms of scientific integrity.

Although the hearings failed to substantiate these serious charges, they nevertheless displayed a number of disturbing beliefs about science and its relationship to policymaking which are detailed in this report:

1. **Repudiating Peer Review.** The hearings not only reflected a fundamental mistrust of government-funded science, but also a mistrust of the entire process of peer review as a means of ensuring the quality and integrity of science. Instead, the hearings exhibited the view that scientific truth is more likely to be found at the fringes of science rather than at the center. Such an assumption seriously distorts the history of science and reflects a disturbing repudiation of the scientific process and peer review. Such a view is inimical to a constructive role of science in policymaking and hinders the ability of science to build scientific consensus on matters relevant to both domestic and international policymaking.
2. **Congress as Science Court.** Presented as a contest between equally valid scientific views, the hearings were portrayed as a scientific court where the Subcommittee would determine scientific truth through testimony and questions. By substituting its own judgment for that of the scientific community, the Subcommittee achieved exactly what it purported to condemn: the politicization of science.
3. **Policy Paralysis through "Sound Science".** The hearings reflected a definition of "sound" science which would entirely preclude the consideration of certain types of scientific

knowledge in favor of "empirical facts." In fact, this definition has nothing to do with the quality of science. It merely reflects a policy position which would require unrealistic scientific certainty before any regulations could be justified. The definition would make it virtually impossible to pass regulations intended to prevent environmental harm before it occurs.

4. **Hanging First, Trial Later.** The hearings were an attempt to create an after-the-fact justification for efforts to cut environmental research budgets, particularly in areas unpopular with the Committee's Republican leadership.
5. **Heat, not Light.** The country faces complex environmental decisions that involve difficult policy choices and the consideration of important competing interests. These difficult decisions will not be made easier by diversionary attacks on illusory issues involving "scientific integrity."

The report recommends that the 105th Congress turn towards a more constructive debate on ways to reconcile the often sharply different value judgments that largely shape the political disagreements on environmental policy issues, and to turn scientific issues back to the scientific community and the time-tested process of peer review as the best means of ensuring quality and objectivity. The report also recommends that Congress routinely require scientific witnesses to disclose funding sources, much as scientific journals already do. Finally, the report recommends that the scientific community take much more seriously the responsibility to educate the public and policymakers about the importance of the scientific process and peer review, and to respond to the arguments raised by the scientific "skeptics" who have taken a highly visible and public role in criticizing mainstream science on these issues.

The Assault on Environmental Science

I. Introduction

The last several years have seen an increasing chorus of charges, primarily from conservative think tanks and special interest groups, that costly environmental laws and regulations are often passed without "sound" scientific evidence of a "real" environmental problem. Such critics argue that environmental problems have been systematically exaggerated by an unholy alliance of scientists eager for increased Federal research funding and environmentalists pushing a political agenda. They claim that scientific views which might undermine the environmentalists' political agenda have been systematically suppressed. In short, these critics believe that science, particularly environmental science, has been distorted to serve political purposes.

These claims found a particularly receptive audience in the Republican majority of 104th Congress, which set as one of its primary goals the establishment of a new paradigm for environmental policy and environmental law.¹ Congressional critics of environmental regulations called for "sound" science as a basic element of regulatory reform.² Repeals, rollbacks, and research budget cuts were all asserted to be required by "sound" science. For example, proposed budget cuts to the global climate change research program were justified on the grounds that the program represented politicized science that was a "product of basically the Vice President of the United States' zeal for this particular issue. Many of us believe that that zeal is what we would call environmental fanaticism."³ The recent Republican platform reflects similar sentiments in its statement that proposals to reduce greenhouse gas emissions have "leapfrogged over reasoned scientific inquiry."⁴

For its part, the Republican leadership of the Committee on Science indicated early in the 104th Congress its intention to oversee the "integrity of science" by promoting reliance on "empirically sound data" and by protecting scientists from political influences on their scientific work.⁵ The Chairman of the Science Subcommittee on Energy and Environment, Mr. Rohrabacher, announced his intention to conduct an investigation of possible political pressure on the scientific process a few weeks into the session:

"We are looking into charges that political pressure was put on people to make scientific decisions. And we may have a hearing if we find evidence on that. We may be holding a hearing on that to expose that type of indefensible behavior on the part of certain government officials"⁶.

¹ Reforming the regulatory process by requiring strict new risk assessments ("sound science") and cost-benefit analyses was one of the Republican "Contract with America" provisions brought to an early vote in the House in the 104th Congress by the new Republican leadership. See, *generally*, legislative history of H.R. 9, the Job Creation and Wage Enhancement Act of 1995.

² See, e.g., Rep. Tom Delay ("That is what regulatory reform is all about... to make [agencies] do their jobs with a little common sense and with good science." 141 *Cong. Rec.* H2416 (March 1, 1995)); Rep. Robert Walker ("We have regulations run amok... we need to get the good science." 141 *Cong. Rec.* H2268 (Feb. 27, 1995)); Rep. David McIntosh (protect "regulated community, average Americans, from the threat of... regulations that do not meet the test of good science and cost-benefit analysis." 141 *Cong. Rec.* H2327 (Feb. 28, 1995))

³ Rep. Dana Rohrabacher, 141 *Cong. Rec.* H9942 (October 12, 1995)

⁴ Republican Platform on Science and Technology, *Power for Progress*, August, 1996.

⁵ The Science Committee "Vision Statement," submitted by Chairman Robert Walker to the House Republican Conference during the 104th Congress, contained (among other things) the following Strategies to Promote Scientific Integrity: "Science programs must seek and be guided by empirically sound data; The results of scientific research must be completely and accurately reported without fear or favor; Scientific research must be merit reviewed in an open and competitive process."

⁶ Interview with Dan Greenberg in *Science and Government Report*, February 15, 1995.

This investigation culminated in 1995 in three Subcommittee hearings convened to showcase areas in which science had been allegedly distorted: the 1992 decision to accelerate the ban on chlorofluorocarbons (CFCs) to protect the stratospheric ozone layer;⁷ proposals to reduce carbon dioxide and other greenhouse gas emissions to slow down global warming;⁸ and proposals to regulate dioxin-containing chemicals to protect human health.⁹ The hearings focused on allegations that these environmental problems had been systematically exaggerated to the public, the media, and policymakers, and that contrary scientific data and views had been systematically ignored or even actively suppressed.

These charges are serious in themselves. But equally importantly, the way in which the Subcommittee pursued these allegations provides a valuable window into the many assumptions - hidden and overt - which underlie the Majority's views toward the conduct of science and the use of science in the formulation of policy.

This report first discusses the allegations that environmental science has been politically compromised, as well examining some of the unconventional views and assumptions held by the Majority on questions relating to the conduct of science and its use in policy formulation. The report then assesses whether any of the allegations of impropriety were actually substantiated during the hearings process. (The case studies prepared by the Minority staff are appended to this report and contain a detailed discussion of the allegations and the actual evidence produced at the hearings.) The report next examines the effects that the Majority's views have had (and will continue to have, if unchecked) on science, science policy, and environmental policy. Finally, the report concludes with a series of recommendations on how Members of the Congress and the scientific community might strengthen environmental science and its link to the policy process.

⁷ *Scientific Integrity and the Public Trust: The Science Behind Federal Policies and Mandates: Case Study 1 - Stratospheric Ozone: Myths and Realities*, Hearing Before the Subcommittee on Energy and Environment of the House Committee on Science, 104th Cong., 1st Sess., No. 31 (September 20, 1995)(Hereinafter cited as "Ozone Hearing").

⁸ *Scientific Integrity and the Public Trust: The Science Behind Federal Policies and Mandates: Case Study 2 - Climate Models and Projections of Potential Impacts of Global Climate Change*, Hearing before the Subcommittee on Energy and Environment of the House Committee on Science, 104th Cong., 1st Sess., No. 35 (November 16, 1995) (Hereinafter cited as "Global Climate Change Hearing"). In addition, a panel also testified about global climate change science during a Full Committee hearing on NASA's Mission to Planet Earth: *U.S. Global Change Research Programs: Data Collection and Scientific Priorities*, Hearings before the House Committee on Science, 104th Cong., 2nd Sess., No. 49 (March 6, 1996).

⁹ *Scientific Integrity and Federal Policies and Mandates: Case Study 3 - EPA's Dioxin Risk Reassessment*, Hearing before the Subcommittee on Energy and Environment of the House Committee on Science, 104th Cong., 1st Sess., No. 39 (December 13, 1995) (Hereinafter cited as "Dioxin Reassessment Hearing.")

This report shows that the three hearings were much more than a platform for critics to air charges which ultimately proved to be baseless. The hearings constituted an unprecedented assault on the peer review system and the scientific process itself. In the end, the hearings conducted by the Committee Majority demonstrated a lamentable lack of understanding of science and of policy, and a real danger to effective linkages between the two.

II. The Subcommittee's Allegations and Assumptions

A. Allegation: Science Has Been Distorted to Serve Politics

The 104th Congress has been fertile ground for the allegations sown by conservative think tanks and special interest groups that science-based environmental policies have been systematically distorted and misrepresented for political purposes.¹⁰ The three Subcommittee hearings focused on allegations that researchers had deliberately overstated environmental problems to mislead policymakers, and had willfully ignored and even suppressed contrary scientific information and viewpoints. The Chairman and witnesses made a number of specific allegations, discussed in detail in the appended case studies, including the following claims:

- NASA and EPA deliberately overstated the risks of stratospheric ozone depletion;
- Scientists presented testimony before Congress which deliberately understated inherent uncertainties in climate models;
- Scientists distorted research results to secure continued Federal funding and EPA conspired to distort the risk of a regulated substance;
- Grant applications were inappropriately denied for ozone depletion research based on political convictions;
- Politically unpopular dissenters were systematically excluded from international scientific assessments of ozone depletion and global warming;
- A publication suppressed an article dealing with ozone depletion in the scientific literature because of biased editorial policy; and
- A scientist critical of global warming was denied data.

¹⁰ Conservative Washington think tanks have published a plethora of books and articles over the last few years criticizing environmental policy and the alleged manipulation of environmental science. See, e.g., Bailey, Ronald (ed.), *The True State of the Planet*, (New York; 1995) [a project of the Competitive Enterprise Institute]; Bast, Joseph et al, *Eco-Sanity* (Lanham, Md; 1994) [Heartland Institute]; Milloy, Steven, *Science Without Sense: The Risky Business of Public Health Research*, (Washington; 1995) [CATO Institute].

B. Assumption #1: Peer Review is Suspect and the Unconventional Scientific Fringe is Probably Right

The hearings displayed a fundamental distrust of government-funded science and the process by which scientific assessments are developed through open and peer-reviewed procedures.¹¹ A number of the witnesses attacked the traditional peer review process as corrupt and politicized. The hearings appeared to bestow greater scientific credibility on the non-peer-reviewed views of individual scientists than on the peer-reviewed scientific assessments.¹² In that regard, the hearings reflected a fundamental disregard for the scientific process itself and undermined the very credibility of science as a basis for making policy decisions. In his testimony rejecting the international scientific assessment of ozone depletion science, for example, Rep. John Doolittle expressed contempt for the "mumbo-jumbo of peer-reviewed documents" and expressed his preference for the views of the few "skeptic" scientists.¹³

Indeed, the "skeptic" scientists¹⁴ were perceived to be all the more credible precisely *because* their views were contrary to the consensus of peer-reviewed science. Citing historical instances where unconventional theories successfully overturned conventional wisdom, some Members and witnesses suggested that scientific "truth" is usually more likely to be found at the scientific fringes than in the conventional center.¹⁵ As the Subcommittee chair stated, "I am not swayed

¹¹ As practiced today, the term "peer review" refers to different things in different contexts. Most narrowly, peer review refers to the process by which an original article is circulated to independent knowledgeable reviewers to determine an article's scientific quality before publication in a scientific journal. "Peer review" also refers to the process by which an assessment of scientific knowledge, which itself draws upon scientific peer-reviewed literature, is reviewed by an independent panel of experts to ensure that the assessment reasonably reflects the state of scientific knowledge on a subject.

¹² In the ozone hearing, Rep. Tom Delay admitted that he had not seen the WMO international assessment, but readily dismissed it anyway: "I haven't seen this study, so I can't comment on this particular study. But it's been my experience that a selective group, in fact, is usually taken - well, let me put it a different way. The conclusion is usually written before the study is even done." Ozone Hearing, *supra*, at 28. Instead, he based his assessment that there was no scientific basis for ozone depletion on "reading people like Fred Singer,... reading Arnie Goldback from Norway, reading others." *Id.*, at 29.

¹³ When asked what peer-reviewed science he had relied upon for his conclusion that there was no scientific basis for ozone depletion, Rep. Doolittle responded "[w]ell, you're going to hear from one of the scientists today, Dr. Singer.... I consulted Dr. Singer, who is a very authoritative source, and I will stand with the Doctor." *Id.*, at 19.

¹⁴ All scientists are skeptics because the scientific process demands continuing questioning. In this report, however, the scientists we refer to as "skeptics" are those who have taken a highly visible public role in criticizing the scientific consensus on ozone depletion and climate change through publications and statements addressed more to the media and the public than to the scientific community.

¹⁵ See, e.g., Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press; 1962) for the seminal discussion of the role of "paradigm shifts" in the history of science. Defenders of "skeptic" scientists frequently cite historical examples where
(continued)

by arguments that 'here's a big list of scientists that are on my side and you only have a smaller group of scientists on your side.' I'm just not swayed by that at all."¹⁶ A similar sentiment was echoed by the Chairman of the Science Committee: "My experience in 18 years of watching science policy being made is it is often those small groups of scientists, though, who differ with conventional wisdom that in fact are always producing the scientific judgments of the future."¹⁷

C. Assumption #2: Sound Science is Empirical Science

One of the overall messages of the hearings - that Congress should act as the arbiter of scientific disputes - becomes extremely problematic if Members of Congress are consistently confused about the nature and the limitations of scientific knowledge. And, in fact, these hearings were a case study in confusion. One example was the oft-repeated view of "skeptical" witnesses and Republican Members that "sound" science is "empirical" science.¹⁸ In both the ozone hearing and in the global change hearing, for example, "skeptical" witnesses rejected the use of statistical analysis and models in favor of *observational* data -

unconventional theories were actively suppressed by the establishment. See, e.g., "George Miller, Meet Galileo Galilei", Dear Colleague circulated by Rep. John Doolittle (Sept. 26, 1995): "[I]t is [Rep. George Miller] and other supporters of the CFC ban who want to keep the scientific debate closed. Accept conventional wisdom or else, is what he seems to be saying. Can you imagine how Mr. Miller might have reacted to other dissenters in the scientific community? Consider Galileo Galilei...."

¹⁶ Ozone Hearing, *supra*, at 155. Contrast this view with the goal expressed in the 1996 Republican Platform which proposes, under "Restoring Justice to the Courts," to "eliminate the use of 'junk science'... by requiring courts to verify that the science of those called as expert witnesses is reasonably acceptable within the scientific community...."

¹⁷ Rep. Robert Walker, *Cholesterol Measurement: Error and Variability*, Hearing before the Subcommittee on Technology of the House Committee on Science, 104th Cong., 1st Sess., No. 4 (February 14, 1995) at 125-126. Similar sentiments have been expressed by "skeptical" scientists to bolster their position that the scientific consensus is irrelevant. "[T]he most progress in science is made when researchers challenge existing paradigms, the most overarching of which is that we are doomed." Michaels, Patrick, "Free Markets, Free Science," *Washington Times* (Dec. 15, 1992, p. F2). In testimony before the Science Subcommittee on the Environment in 1992, Dr. Michaels expanded this view about scientific consensus: "The question you're asking implies that science by large consensus is, in fact, correct. And I don't think the history of science, in fact, argues that consensual statements, in fact, turn out to be correct in the long run." *U.S. Global Change Research Program*, Hearing before the Subcommittee on Environment of the House Committee on Science, 102nd Cong., 2nd Sess., No. 148 (May 5, 1992), at 174. Dr. Michaels has also said, "The premise is that consensus defines truth in science. The pressure to conform then comes to outweigh the openness to challenge and debate." Michaels, Patrick, "Forging Consensus: Climate Change and the United Nations" (Washington: George C. Marshall Institute; 1996). Such sentiments may also explain the high funding priority placed by the Majority on research on "revolutionary ideas and pioneering capabilities that make possible the 'impossible.'" See, e.g., "Views and Estimates on the FY97 Budget Submitted to the Committee on the Budget by the Committee on Science" (1996).

¹⁸ Science Committee Vision Statement, Note 5, *supra*. See, e.g., Singer, F., "Confusing Science with Speculation," *Washington Times*, Aug. 16, 1993, at E1.

even when the use of uncorrected raw data was highly misleading.¹⁹ The hearings reflected a systematic aversion to the use of theory, models, and other sources of scientific knowledge to provide a full understanding of observed data.

This inordinate reliance on a single source of scientific understanding is part of a broader view that the "sound science" needed before regulation can be justified is science which somehow proves a proposition to be "true."²⁰ This is a totally unrealistic view both of science's present capabilities and of the relationship between data and theory in the scientific method. Not coincidentally, as the report discusses in later sections, this approach to science can lead to near paralysis in policymaking.

D. Assumption #3: The Trial Can Follow the Hanging

As an exercise in the relationship between the hearings process and legislative action, the hearings were a prime example of "hanging first, trial later." Months before the hearings, the Subcommittee Chairman had already proclaimed his belief that the global change issue was "liberal clap trap."²¹ Without the benefit of hearings, the Science Committee in June, 1995 approved legislation,²² later passed by the House of Representatives, which included dramatic cuts in environmental research, particularly in climate change and energy research. Other Members introduced legislation to roll back the ban on CFCs based on

¹⁹ For example, in the ozone hearing, Dr. Singer testified that the fact that there were no empirical data showing an actual increase in surface level UV radiation must mean that stratospheric ozone was not being depleted. See, e.g., Ozone Hearing, *supra*, at 51, 56-57. However, Dr. Albritton testified that there was a reason for the lack of data: detecting trends in surface level UV radiation is extremely difficult because of interference from clouds and pollution. *Id.*, at pp. 39-40, 170. The fact that there is no empirical proof of increased surface radiation does not mean that stratospheric ozone depletion is not occurring. Other direct satellite observations do, however, provide evidence that such depletion is taking place. See, e.g., statement of Dr. Albritton, *Id.*, at 38. To be certain, predictive models have their own set of problems as described by the General Accounting Office in the global warming hearing. The scientific method, however, is intended to reconcile empirical observations and predictive models and unify a common framework of understanding. Neither constitutes "sound" science in isolation.

²⁰ "[B]efore there is something *proven* to be a health risk, passing regulations that will cost billions of dollars to the American people is not justified." (emphasis added) Rep. Rohrabacher, Dioxin Reassessment Hearing, *supra*, at 78.

²¹ Rep. Rohrabacher, "Statement at Press Conference on the Energy and Environment Authorization," June 7, 1995. Mr. Rohrabacher also stated: "In another area of savings, trendy science that is proposed up by liberal/left politics rather than good science has cost us billions.... We will not permit scare mongers and Chicken Littles to successfully push Federal policies that tax our people into lower standards of living, raise the price of products they buy and regulate them out of a job. Nowhere is scientific nonsense more evident than in global warming programs that are sprinkled throughout the current year budget."

²² H.R. 1814, H.R. 1815, and H.R. 1816, later incorporated into H.R. 2405.

their belief, unconfirmed by any open hearings process, that the scientific basis for the ban had been politically distorted.²³

III. Were the Allegations and Assumptions Proven?

As detailed in the appendices to this report, the hearings failed to produce credible substantiation for any of the allegations of scientific misconduct and made no coherent case to buttress the sweeping assumptions concerning science policy. On the contrary, the hearings showed that the integrity of the scientific process is sound.

Despite the central focus of this series of hearings and subsequent efforts to develop specific factual evidence, there was no substantive corroboration of any of these charges. Nor was it demonstrated that the alleged incidents leading to these charges had any influence on the interpretation of science for policy. In short, no actual cases of scientific fraud, unacceptable conduct by any individuals or institutions, or breakdown in the scientific process were documented.

In each of the cases considered, the record showed that environmental research was carried out in an objective manner, consistent with the traditional norms of scientific integrity, and without preconceived political or scientific outcomes. Moreover, the record also showed many efforts by those scientists to convey to policy makers the complexity, uncertainties, and limitations of their science. Rather than ignoring contrary data or suppressing dissenting views, the research programs reviewed in these hearings instead demonstrated a remarkably open and transparent process that relied heavily upon critical scientific peer review to ensure quality and integrity.

Clearly, a wide disparity in scientific opinion exists for many important issues having policy implications. Although there exists a high level of scientific consensus on ozone depletion and global climate change, *some* scientists do disagree. Beyond this observation, however, no instances of illegal, unlawful, unethical, or even inappropriate acts could be validated.

These hearings were aimed at discrediting the environmental movement, the Federal Government, and the science community itself. At best, these assertions of lapses of integrity can be characterized as an investigation into the possible breakdown of scientific integrity (which could not in fact be shown). At worst, they were a mythical distortion with the potential to obscure honest and open

²³ Rep. John Doolittle introduced H.R. 2367 to repeal the accelerated phaseout of CFCs; Rep. Tom Delay introduced H.R. 475, repealing the entire section of the Clean Air Act providing for the authority to phase out ozone depleting chemicals.

debate, to compromise the scientific process, and to cause great damage to human health and the environment.

IV. Impacts of the Subcommittee's Allegations and Assumptions on Science and Policy

A. The Subcommittee Demeaned Peer Review and Looked for Scientific Truth at the Fringes

The hearings contrasted remarkably different concepts of science and the role of scientists in public policy. On the one hand, the testimony of agency scientists reflected the results of extensive efforts to analyze and assess the scientific peer-reviewed literature through an open process.²⁴ Each of these assessments disclosed key uncertainties and assumptions, and, consistent with sound risk assessment principles, addressed only scientific issues - not policy recommendations.²⁵

²⁴ Dr. Albritton testified at the ozone hearing that he and Dr. Watson were representing not their own work, but the peer-reviewed research of hundreds of international scientists conducted since 1981. The 1994 *Scientific Assessment of Ozone Depletion*, the seventh such international assessment, is the most authoritative source on ozone depletion science. Over 200 scientists were contributors, and another 147 were peer reviewers. The report was prepared in a thoroughly transparent, public, and open manner.

Similarly, in the climate change hearing Drs. Watson and Mahlman presented the scientific consensus of the Intergovernmental Panel on Climate Change (IPCC), created in 1988 by the World Meteorological Organization (WMO) and the U.N. Environment Programme. At the time of the hearing, the IPCC was about to approve its Second Assessment Report. The "Summary for Policy-makers and Technical Summary," based on the work of hundreds of scientists, were drafted by 78 lead authors from 20 countries and reviewed by 500 reviewers from 40 countries. The Summary was approved, line-by-line, by the 177 delegates to IPCC Working Group 1 in November, 1995. Dr. Mahlman referred to the IPCC report as "the most widely accepted statements ever on climate change." Global Climate Change Hearing, *supra*, at 17.

EPA's draft Dioxin Reassessment was begun in 1991 and involved extensive public outreach and peer review. In September 1994, EPA released for public comment a draft reassessment consisting of two thousand-page documents. A year later, EPA submitted the entire document and all public comments to its Science Advisory Board for independent peer review.

²⁵ The 1983 National Research Council report, *Risk Assessment in the Federal Government: Managing the Process* (Washington: National Academy Press; 1983), recommended that the scientific process of risk assessment should be "explicitly distinguished from the political, economic, and technical considerations that influence the design and choice of regulatory strategies." [p. 7]. With respect to the ozone assessment, Dr. Albritton testified, "They are a solid basis for decision-making, in contrast to anecdotal statements or privately published viewpoints. They are pure science. The community makes no policy recommendations. That's the job of others, like yourselves, that are entrusted with the public welfare." Ozone Hearing, *supra*, at 65. Similarly, in the global change research hearing, Dr. Mahlman was careful to avoid policy pronouncements: "... as a physical scientist, I do not offer personal opinions on what society should do about these predicted climate changes. Societal actions in response to greenhouse warming involve value judgments that are beyond the realm of climate science. Indeed, I would (continued)

In contrast, in the ozone hearing, the Subcommittee heard testimony from Dr. Fred Singer and Dr. Sallie Baliunas, the latter testifying in her capacity as the chair of the Science Advisory Board of the George C. Marshall Institute. The criticisms of the scientific consensus contained in Dr. Singer's²⁶ and Dr. Baliunas'²⁷ testimony have not, to our knowledge, been published in any original peer-reviewed research.

There is, of course, nothing wrong with scientists exercising their rights as citizens to advise Congress on what they believe to be appropriate policies. But such policy advice is nothing more than personal opinion which is entitled to no more deference than that which should be afforded to the opinions of other thoughtful citizens. Scientists have no special expertise to judge the many economic and political issues involved in any regulatory decision. Indeed, it is for that reason that scientists generally try to limit their advice to scientific issues within their expertise, or at least clearly distinguish between science and

invite your skepticism whenever you hear a climate scientist's prediction being accompanied by a policy opinion." Global Climate Change Hearing, *supra*, at 16. Referring to EPA's draft dioxin reassessment, Dr. Farland testified, "The reassessment is a scientific document and does not address regulatory policy or issues." Dioxin Reassessment Hearing, *supra*, at 23.

²⁶ A literature review revealed only one recent peer-reviewed article on ozone depletion by Dr. Singer. The article is not original research, but a technical comment in *Science* co-authored by Dr. Singer (Michaels, P.J.; Singer, S.F.; Knappenberger, P.C., "Analyzing Ultraviolet-B Radiation: Is there a trend?", *Science*, **264**, 1994, p. 1341). The article criticized statistical techniques in a study purporting to detect a trend in UV-B radiation associated with ozone depletion (Kerr, J.B; McElroy, C.T., "Evidence for Large Upward Trends of Ultraviolet-B Radiation Linked to Ozone Depletion," *Science*, **262**, 1993, p. 1032). *Science* also published a response by the original authors to the criticism by Singer and his co-authors.

Dr. Singer testified that he had also published peer-reviewed articles in *EOS* and *Technology: The Journal of the Franklin Institute*. Ozone Hearing, *supra*, at 165-166. *EOS*, the journal of the American Geophysical Union, is a weekly newsletter, not a traditional scientific journal. As its editor-in-chief wrote in a letter to Rep. Rivers, *EOS* "publishes commentary on scientific programs and their results, short reviews of research results and activity, and opinion intended to stimulate scientific debate." While such articles are reviewed by one or more active scientists for "interest, clarity, and soundness of the science," *EOS* does not publish new scientific results subject to the traditional peer-review process.

Technology, a new journal separate from its parent publication, *The Journal of The Franklin Institute*, has published only three issues with a very limited circulation (Ozone Hearing, *supra*, at 165, and letter submitted for the record, p. 320 *et seq.*). According to *Technology's* editorial guidelines, Dr. Singer's article is a "Commentary," which would not be peer reviewed.

Dr. Singer has noted (Ozone Hearing, *supra*, p. 307) that he has published in many peer-reviewed journals. Dr. Singer did publish actively in the 1970s scientific literature on ozone and other global environmental issues. He has also been a prolific writer of op-ed articles for the *Washington Times* and other conservative publications. The point here, however, is simply that Dr. Singer's current views on ozone depletion science have not been published in the scientific peer-reviewed literature.

²⁷ Dr. Baliunas has many peer-reviewed publications in her specialty, solar astrophysics, but her criticisms of ozone and global change science have been published only by the Marshall Institute, whose reports are not peer reviewed, according to published reports. In "Attacks on IPCC Report Heat Controversy Over Global Warming" (*Physics Today*, August 1996, at 57), Toni Feder quotes Dr. Frederick Seitz, Chairman of the Marshall Institute, as saying that Marshall reports are not peer-reviewed and "represent opinion."

personal opinion. This is a standard which "skeptical" scientists frequently fail to meet in their publications.²⁸

As evidenced by earlier-cited comments, Subcommittee Members were quite comfortable both in enthusiastically accepting the policy pronouncements of "skeptical" scientists and in demeaning the careful peer-review efforts of traditional scientists. Peer review was almost flippantly dismissed as politically correct tyranny, as opposed to the true scientific breakthroughs generated by the unconventional and skeptical innovator.

The sentiment that the scientific fringe is more likely to be right than conventional scientific knowledge reflects a disturbing misunderstanding by some Members not only of the scientific process but of scientific history as well.

Skepticism is an inherent part of the scientific perspective; scientific knowledge grows only through a process of continual questioning. The central accepted core of our scientific knowledge is the cumulative result of centuries of resolving scientific questions through observation, testing, and open and rigorous scientific peer review. The consensus that has emerged from this process deserves respect as our best effort to understand and explain the physical world. Like Winston Churchill's democracy, peer-review is not a perfect process, but it is the best that we have.

While scientific breakthroughs that challenge conventional wisdom do occur, it is a perversion of scientific history to say that the conventional wisdom - the product of the peer review process - is more often than not wrong. Further, while "skeptical" scientists are unquestionably correct that their theories are not wrong simply because they are not popular, the burden must be on the challengers to show that the conventional wisdom is wrong, by the scientific process of developing and testing alternative hypotheses subject to open and rigorous peer review. Those who would wear Galileo's mantle must also meet Galileo's commitment to science's rigorous demands.

For the most part, "skeptical" scientists have failed to confront conventional wisdom in a valid scientific forum. Instead, they have chosen to present their

²⁸ For example, Marshall Institute reports on ozone and climate change make policy recommendations based on the "scientific" conclusion that policy actions are not justified. As noted in the text, *infra*, such a conclusion is a policy, not a scientific, conclusion. Other policy matters are included in the Marshall reports as well. In "The Ozone Crisis," Dr. Baliunas extensively discusses the economic impacts of the CFC phase-out and the wisdom of the "precautionary principle" policy, concluding that the phase-out "appears both scientifically unjustified and unnecessarily costly." At the hearing, however, Dr. Baliunas was much more restrained about her policy qualifications. She declined to state her position on the CFC phaseout: "It's just that it involves a broader issue than the science. It involves the risk/benefits. And I can't comment on those, and the second panel shall. It involves an economic question as well."

views in opinion pieces aimed not at their fellow scientists but at policymakers, the media, and the general public. And because the skeptics often present subtle misinterpretations of results and undocumented analyses with each new hearing or op-ed piece, their arguments are difficult to rebut by the methods normally utilized by the scientific community.

In lionizing the methods of the skeptic community, the Subcommittee has damaged the peer-review process, displayed its ignorance of the history and conduct of science, and failed profoundly in its responsibility to educate and enlighten the 104th Congress on the contributions of science to society.

B. The Subcommittee's Embrace of Skeptic Science Is a Threat to Domestic and International Consensus Building and to a Constructive Role for Science in Policymaking

A key allegation throughout these hearings was that the link between the scientific process and the policymaking process is flawed. For the climate change hearings, the testimony of skeptics was taken as proof that the peer review process has failed and that unsound science was being used for major decisions. The structure of these hearings and the selection of viewpoints to be heard were aimed at showcasing the "skeptics'" interests. Although mainstream science was represented, it was cast in a defensive posture²⁹ and the true link between the consensus process and policy making was obscured.³⁰

Through these hearings, there emerged the outlines of an alternative proposal for policy making. That is, rather than relying on the traditional consensus process that has characterized the Intergovernmental Panel on Climate Change (IPCC), the Montreal Protocol process, and Federal regulatory review panels, the hearings profiled the "think tank" process in which scientific opinions can be developed unencumbered by the peer-review process. The hearing in fact gave equal weight to witnesses representing both processes.

Some have argued that high profile think tank and "skeptic" scientists, while they may not be an integral part of the science process, are a part of the public opinion process and should be afforded a platform. The issue of relevance is not whether "skeptics" should be heard but *how* such individuals and think tanks are used by Congress in developing policy and legislation.

²⁹ Witnesses who were part of the traditional scientific community stopped short of conveying personal opinions - properly believing that policy matter were outside their expertise. Thus, throughout the hearings, many exchanges between witnesses seemed unbalanced - strongly expressed policy opinions on the one hand versus highly qualified scientific responses on the other.

³⁰ For example, there was no representation from the critics at the opposite end of the spectrum, i.e., those who believe the consensus process is too conservative and more proactive policies are needed. The consensus represents a balance in this spectrum of viewpoints.

In encouraging and supporting the views of "skeptical" scientists who do not participate constructively in peer review processes, the Subcommittee has undercut domestic and international consensus-building processes which aim to link science and environmental policy. If it is successful, the Subcommittee will have discredited the best available mechanism for establishing environmental policy, leaving nothing in its place except raw political influence.

C. By Turning Congress into a Science Court, the Subcommittee Has Politicized Science

Although skepticism has long been an essential part of the scientific process, the emerging role of "skeptics" within the policymaking process has been confusing and counter-productive. The receptivity of the 104th Congress to their views has distorted the true cases of consensus where consensus exists and has led to a perception that science itself cannot be trusted for policymaking.

A perception has been created that, for any scientific issue, *there will always be some scientists in agreement and some in disagreement, scientists will invariably change their minds, and no reliable process exists to resolve scientific differences of opinion with any degree of integrity.* This cynical view in fact does undermine science-based policymaking. It leads to the conclusion that institutions such as Congress have been ceded the responsibility to define what is sound science and to act as a science court.

This emerging view, based on a fundamental mistrust of the process, establishes the science community as *just another interest group*. Large numbers of scientists subscribing to a consensus are simply a *large* interest group. "Skeptics," on the other hand, are viewed as an equally credible, but smaller interest group. Within this new framework, policymaking will be dominated by politics rather than science. That is, small interest groups with greater access have the potential to achieve more than larger interest groups with diminished access.

The idea that politicians rather than scientists should decide what constitutes "sound science" should be deeply disturbing to those concerned with the integrity of the scientific process. Yet in these hearings, the Subcommittee acted as a "science court", leaving to the judgment of Members which science to believe based on little more than the persuasiveness of five-minute presentations and question sessions.³¹ Science is not a political debating contest. Scientific "truth"

³¹ "I came away [from the ozone hearing] thinking, well, the people who were talking about ozone certainly made their case. But when we had the people there talking about global warming, they didn't make their case at all. And they were, as far as I could see, they were shot down totally by the people presenting the other side of the argument." Rep. Dana Rohrabacher, statement made during Committee consideration of H.R. 3322, April 24, 1996. *Omnibus Civilian Science (continued)*

is unlikely to emerge in such a legalistic, adversarial setting; it cannot, like policy options, be chosen from a menu of alternatives. Yet the Committee routinely dismissed the scientific viewpoint established through rigorous peer review in favor of an untested scientific viewpoint which had only the benefit of supporting a preferred policy outcome.³²

What are the implications of this new view of science for future Congressional decisions on the environment? There was a disturbing common theme to these hearings suggesting that research funded by the Federal Government is not sound science, since scientists have economic incentives to exaggerate the importance of their research.³³ In this view, "consensus" science derived from peer review is not sound science, since it merely reflects a conspiracy of the scientific establishment which suppresses dissenting views. Finally it was implied that science which has any uncertainty or which is not "empirical" is not sound science. What is left?

If we accept these propositions, science becomes something that policymakers can simply pick and choose depending upon their own personal political preferences and the persuasiveness of slick packaging. With the credibility of peer-reviewed science undermined by political attacks, the 104th Congress has signaled its intention to make its own decisions about what constitutes "sound" science, thereby ensuring precisely what it said it wanted to avoid: the politicization of science.

The deep-rooted distrust of science funded by government, the lack of respect for the scientific peer review process, and the lack of understanding of distinctions between science and policy matters displayed by the 104th Congress all but assures continuing attacks by special interest groups on the scientific basis of environmental regulations.

Authorization Act. Report to accompany H.R. 3322, Committee on Science, 104th Cong., 2nd Sess., H. Rpt. 104-550 (Part 1), p. 541.

³² The complexity of science provides a further caution to the idea of Congress acting as a "science court", especially when politicians are generally ill-equipped to judge the merits of complex science. One of the key controversies in the EPA Dioxin Reassessment was EPA's assumption that dioxin could be considered to have a linear dose-response, which could mean that even relatively small increases in exposure could pose health risks - an assumption opposed by the chemical industry. However, Chairman Rohrabacher expressed his frustration in understanding the testimony on this critical issue: "I don't know how many people on this panel understand it or this committee understand it, but I am sure that it's an important question, and we need to make sure that people are on the record even on issues that the committee doesn't understand." Dioxin Reassessment Hearing, *supra*, at 64.

³³ Part of the distrust of environmental science appears to stem from the fact that most environmental research is funded by the federal government. Some critics have questioned the inherent credibility of such research because of the potential self-interest of researchers in exaggerating the importance of their research - or, as one witness wrote, to be "shills for the apocalypse." Michaels, Patrick, "Free Markets, Free Science," *Washington Times*, December 15, 1992 (p. F2).

D. The Subcommittee's Definition of "Sound Science" Creates an Impossible Burden of Proof for Science, Thereby Undercutting All Environmental Regulation

The hearings illustrate a newly emerging theme (enunciated in the Republican vision statement for scientific integrity) equating *sound* science with *empirical* science. Throughout these hearings it was clear that although all Members advocated the use of "sound" science, there was no universally accepted definition of what it meant. Rep. Doolittle, in his prepared statement for the ozone hearing, stated that "Sound science must be the basis for all future decisions we make on this important issue". In seeking to clarify the definition of sound science, Ms. Rivers asked "...[W]hat would you consider to be sufficient evidence for action to be taken in this area?" Mr. Doolittle responded, "I think we need a clear scientific conclusion that there is a definite cause for the problem and that so-called problem is producing definite effects. Theories or speculation about it are not sufficient. We need science, not pseudo-science. I think we've been in an era of pseudo-science where these dire consequences are portrayed in order to achieve a certain political objective." Similar statements were made by other Members in the global change hearing with respect to projections from computer models and in the dioxin reassessment hearing with respect to choices of models of dioxin receptor activity.³⁴

The emphasis on empirical science to the exclusion of modeling represents a fundamental misunderstanding of science itself. The classic scientific method involving *observations, hypotheses, testing of hypotheses, and establishing and refining a theoretical construct* is fundamental to scientific understanding. The emerging effort to truncate the scientific method at the initial observations stage endangers the ability of the scientific community to unify its understanding not only of environmental problems, but any phenomenon.

While it may be understandable that laymen like Members of Congress do not understand all the conceptual tools of modern science, we believe that the Subcommittee's oversight in this case was less accidental and more sinister than it may appear at first sight. *By equating sound science with empirical science, the Subcommittee has attempted to sever the link between peer-reviewed science and policy and to stop environmental regulation in its tracks.*

There are several components of this strategy.

First, limiting what is scientifically admissible to that which is "empirically true" eliminates much of the subtle evidence that both contributes to scientific understanding and supports environmental regulation. Scientific understanding of complex environmental and health problems evolves over time, drawing from

³⁴ See Note 20, *supra*.

different approaches and techniques for testing theories. By eliminating modeling, theoretical constructs, and process studies, the Subcommittee has imposed a totally unrealistic burden on science and has compromised the relationship between data and theory in the scientific method.

Secondly, by demanding empirical "truth", the Subcommittee has effectively severed the link between science and policy. There will always be scientific uncertainties, particularly in dealing with complex areas such as human health and global climate systems. The fact that science cannot always make statements with 100% certainty about a subject does not mean that scientists do not know anything about the subject. For example, even though science still lacks a precise understanding of the mechanisms by which cigarette smoking causes lung cancer, the combined weight of scientific evidence, including clinical and epidemiological research, presents an overwhelming case for causation. Uncertainty is not the hallmark of bad science; it is the hallmark of honest science. The scientist professing absolute certainty is likely the least believable.

Further, no politician should be allowed to cut off a serious public policy debate on the basis that the underlying science is uncertain. Degree of scientific certainty is only one of many factors that enter into policy decisions. Even where there is substantial scientific uncertainty, a policy action might still be justified in a policy-maker's view depending on factors such as the nature, distribution, and significance of the possible harm to be avoided and the cost of implementing the policy to avoid the harm.³⁵ This perennial question - "Do we know enough to act?" - is inherently a *policy* question, not a scientific one. There is no "scientific" way to decide how to make the difficult tradeoffs among uncertainties, costs, benefits, and risks inherent in any policy action. Policy choices invariably involve subjective values about which science has nothing to say. It is therefore meaningless to say, as some environmental policy critics have, that certain *policy* decisions are "unscientific."³⁶

³⁵ Scientific uncertainty is certainly a factor to be considered, since the uncertainty creates the risk that any given regulatory response will be less than optimum. Either the actual risk can be overstated, in which case regulations may not have been necessary, or the actual risk can be understated, in which case regulations have not been sufficient to avoid all of the harm. Where regulatory costs are high, and the benefits uncertain, policymakers could reasonably insist on greater scientific certainty before deciding to regulate. On the other hand, if regulatory costs are low, and the benefits are high, policymakers may place less importance on scientific certainty. How any given policymaker wants to "gamble" on such outcomes will be heavily influenced by the other policy factors mentioned in the text.

³⁶ For this reason, scientists try to distinguish between science issues, on which they are uniquely qualified to speak, and policy issues, on which they have no particular expertise. In regulatory language, these two issues are separated as risk assessment and risk management. While each of the mainstream peer-review assessments challenged in these hearings scrupulously avoided policy pronouncements, many of the "skeptical" scientists who testified at these hearings routinely mix science and policy judgments together in their writings. See, e.g., Baliunas, Sallie, "The (continued)"

In short, then, the term "sound" science as used by Subcommittee Members has very little to do with the quality of science. Instead, it is a policy position that a proposition should be "proven" before any regulatory action can be justified.³⁷ The three hearings examined here demonstrate that waiting for the kind of certain, unambiguous and empirical data called for by Subcommittee Members means waiting until irreversible and irreparable harm has already started happening. In the global change area, waiting for an unambiguous signal of global warming before taking any actions to reduce greenhouse gas emissions adds greenhouse gases to the atmosphere which could make the impacts of global warming worse and mitigation strategies more expensive. Similarly, the atmospheric lifetime of CFCs is so long that it would take centuries to reverse stratospheric ozone depletion if we waited for certain, unambiguous evidence of ozone depletion and increased skin cancer incidence. With respect to dioxin, as in public health in general, public policy is based on preventing adverse human health effects, not waiting for evidence that cancer or other adverse effects have already occurred.

By requiring an unrealistically high level of scientific proof, the Subcommittee has thrown a large roadblock in the path of sensible environmental regulation. Their obstructionism is aimed at reversing the "precautionary principle," which has been the basis for environmental and public health regulations for many decades.

E. The Subcommittee Has Obfuscated and Postponed Constructive Consideration of the Difficult Core Issues in Scientific and Environmental Policy

Congress and the Administration face policy decisions of staggering complexity in dealing with environmental problems and their economic, social and political implications. These decisions, which are inherently non-partisan, involve balancing important social goals such as environmental protection and economic growth. While these hearings could have provided a useful forum for exploring these critical issues, they instead featured a confusing array of scientific distortions, red herrings, false accusations, and vague charges of a breakdown in integrity. Rather than focusing on the real policy choices that need to be made, the Members were presented with a new view of "sound science" that is far different than is generally accepted by the scientific community.

Ozone Crisis" (Washington: George C. Marshall Institute; 1994) ("The Precautionary Principle, as a basis for the formulation of environmental policy, is the denial of science.")

³⁷ Congress could, of course, legally mandate agencies to meet such a high burden of proof to justify regulations. Given the practical difficulty of meeting such a burden, however, agencies would be unlikely to enact regulations intended to prevent harm from occurring. For that reason, environmental laws passed over the last 25 years generally do not require such a strict burden of proof, partly in recognition of high policy priority given to protecting public health and the environment from involuntary environmental risks.

The difficult environmental policy choices that this nation faces will not be made easier by the attacks on the scientific process launched by environmental critics, "skeptic" scientists or their sympathizers in Congress. By creating an illusory controversy over the "integrity" of science, these attacks have not only diverted attention from the real policy choices. They have also turned science into a political pawn, and demeaned its value as a unique and irreplaceable part of a rational decision making process.

F. The 104th Congress was Unjustified in Cutting Funding for Environmental Research Programs

Well before this series of hearings was held, the Science Committee had been actively pursuing a legislative agenda that was unprecedented in its mistrust and hostility toward Federal environmental research programs. For example, the FY96 Budget Resolution, which passed the House in May 1995, recommended a reduction of 20 percent in FY 1996 for Federal environmental research and a steep decline in succeeding years.³⁸ The Science Committee also passed a series of authorization bills throughout 1995 to enact these reductions and to ensure that the appropriations bills were constrained in their budget authority for environmental programs. Although the final appropriations bills were somewhat more moderate (an aggregate reduction of about 12%), compromise was achieved only after intense partisan fights, adverse public reaction, and direct threats of Presidential vetoes.

In addition to budget cuts, the Committee passed legislation to constrain NOAA's climate mission to natural phenomena only and to eliminate the environmental mission of NASA altogether.³⁹ All of these actions occurred prior to this series of hearings and without any actual public record.

It is ironic that the "skeptic" scientists called by the Majority did not, in general, endorse reductions in environmental R&D, particularly climate change R&D. Dr. Nierenberg, for example, noted:

³⁸ American Association for the Advancement of Science, "AAAS Warns Budget Cuts Threaten Future Scientific Enterprise," (August 29, 1995); Hileman, Betty, "Administration Warns of Congress' Attack on Environmental Science," *Chemical and Engineering News*, (June 19, 1995) at 21; Johnson, Jeff, "Lean Times Ahead for Environmental R&D Funding," *Environmental Science and Technology*, Vol. 29, No. 4 (1995) at 180A.

³⁹ See, for example, *National Oceanic and Atmospheric Administration Authorization Act of 1995*, Report to accompany H.R. 1815, H. Rpt. 104-237, p. 32, 33. In addition, although later disputed, a legislative proposal was developed to alter the organic NASA Act which now spells out in section 102(d) "The expansion of human knowledge of the Earth and of phenomena in the atmosphere and space" as a fundamental agency mission. The proposal sought to remove the words "of the Earth".

"I have been advocating increased research in climate affairs ever since I have been in this business for reasons beyond global warming. Whether global warming is to escalate or not is a serious issue. Very little of what we are doing now in research is being wasted."⁴⁰

Other "skeptic" witnesses expressed similar sentiments, possibly because some of the most important issues highlighted in their arguments can be fully resolved only through continued research. These sentiments appear to be at odds with the views of the Subcommittee Chairman, who in April, 1995, characterized global change research as "money right down a rat hole".⁴¹

The hearings developed no serious rationale for reductions in environmental R&D. For example, Chairman Rohrabacher claimed that EPA's Global Change Research Program could be eliminated because it wasn't really science:

"I am taking a look here out of \$111 million contract for global climate research EPA, and their account was used for brochures, posters, program logos, design for product awards, promotional pens, pencils, buttons, banners, displays, billboards, bus and train placards...."⁴²

Later, Ms. Rivers asked Mr. Gardiner of EPA about his budget for Global Change R&D:⁴³

"I have in front of me a list of programs that are being negatively affected by decisions here: The terrestrial carbon flux tracking program; developing predictive models; regional vulnerabilities; integrated assessment research; stratospheric ozone depletion. To your knowledge, are any of those programs engaging in any of the PR kinds of things that were mentioned by the chairman earlier today?"⁴⁴

After Mr. Gardiner responded negatively, Chairman Rohrabacher asserted that the projects listed by Ms. Rivers were fully funded and had not been cut.

⁴⁰ Global Climate Change Hearing, *supra*, at 239. Dr. Nierenberg's statement was echoed by Rep. Roemer, the Ranking Democratic Member, in his opening statement: "Given the enormous costs and benefits [of global warming] it makes eminent sense to do the necessary research to find out as much as we can about global warming.... The policy we have followed of targeting environmental research, belittling the possibility of any impacts and so on, will not make the problem go away, it will only put us on a slower track to understanding this problem"

⁴¹ H. Rpt. 104-550 (Pt. 1), Note 31, *supra*, at p. 540.

⁴² Global Climate Change Hearing, *supra*, at 53.

⁴³ *Our Changing Planet - The FY 1996 U.S. Global Change Research Program* (A Supplement to the President's Fiscal Year 1996 Budget), p 140.

⁴⁴ Global Climate Change Hearing, *supra*, at 240.

Notwithstanding this assertion, on July 21 1995, the Committee directed EPA to terminate its global climate change research program and reduced the budget for global change research from \$22.5 million to \$2.4 million.⁴⁵

If environmental R&D cuts were not supported by Committee oversight nor generally endorsed by hand-picked "skeptic" witnesses, why was the Committee was so aggressive in pursuing them? The answer may well lie in the Majority's desire to end the Federal "monopoly" on research which some conservative critics have seen as the source of demands for environmental protection. Government scientists, such critics argue, have an incentive to exaggerate the importance of their research in order to keep Congressional funding.⁴⁶ The "real problem stems from the monopoly provision of science funding by the federal government."⁴⁷ Since Federally-funded research is tainted, the policy response is obvious - cut the budgets:

"Those who promote federally funded science as a solution to regulatory incompetence have a misplaced faith in bureaucrats.... [P]ublic officials frequently use 'junk science' and fear-mongering to justify greater federal intervention. When bad science arouses the public's fears, public officials stand ready to rescue us from the phony threat.... In the world of policy-making, science is a servant to political interests, and when it doesn't serve those interests it is easily cast aside.... The result of using science as a policy weapon will be the destruction of scientific credibility, not better regulation. In the long run, science will suffer because of federal involvement.... More science funding is not the answer to America's environmental policy problems."⁴⁸

⁴⁵ *Environmental Research, Development and Demonstration Authorization Act of 1995*, Report to accompany H.R. 1814, H. Rpt. 104-199, 104th Cong., 1st Sess., July 25, 1995, pp. 13, 15. Note the confusion between the Global Change Research Program and the Climate Change Action Plan which does generate brochures and other public information items. As best can be determined, the former was cut in response to perceived abuse by the latter.

⁴⁶ Dr. Michaels, who testified at the global climate change hearing, has written: "[A]gencies exist to perpetuate themselves.... The agency goals cannot be accomplished without the largesse of Congress. Thus begins a peculiar back-scratching in which political patrons define a particular problem as The Most Important in History, and the agency responds by testifying that the end is near unless a few billion is spent pronto, and then it will probably be worse than we thought. Such issues and constituencies include the ozone hole (NASA/NSF/EPA), Global Warming (NASA/NSF/DOE/EPA), Sexually Transmitted Diseases (NIH/NSF), or Roughage Shortages (USDA/NIH)...." He called for increased industry funding of basic research so that "scientists will not longer be required to shill for the apocalypse in order to keep their jobs." Michaels, Patrick, "Free Markets, Free Science," *Washington Times* (Dec. 15, 1992). Similar sentiments were expressed by Dr. Stroup at the ozone hearing, where he testified that he didn't expect any lab or agency which gets "better financed when the public and the Congress strongly have a concern" to admit that CFC's are "not a problem." Ozone Hearing, *supra*, at 265.

⁴⁷ Michaels, Patrick, "Forging Consensus," Note 17, *supra*, at 24.

⁴⁸ Georgia, Paul, "When Science Yields to Subversion," *Washington Times* (November 22, 1995) [Mr. Georgia is a research analyst at the Competitive Enterprise Institute.].

If severe reductions in Federal environmental R&D do occur, researchers will look to other avenues of support, such as industry. A key issue in this transformation will be the extent to which the traditional hallmarks of scientific integrity such as peer review and the free and open dissemination of information are maintained. Federally supported R&D, whatever faults it may possess, is generally open, peer-reviewed R&D. As the balance in support for environmental R&D shifts toward industry, there is a danger that external control over the quality or validity of what passes for science will disappear.

G. The Subcommittee has Developed a New and Very Unhelpful Definition of Scientific Integrity

In an earlier discussion of Congress as a "science court", we argued that the Committee routinely dismissed scientific viewpoints established through peer review in favor of untested assertions whose only value was that they supported a preferred policy outcome. The Committee's approach in this regard was extremely troubling, but there is an equally dangerous corollary - namely, the concept that scientific *integrity* is linked to the political *popularity* of the research itself.

The debates that have unfolded during the past several years over scientific integrity - including allegations of falsifying data, plagiarism, and fabrication of results - have presented formidable challenges to the scientific community and to sponsoring institutions. The conduct of science is inherently and intensely human and therefore dependent upon a staggeringly complex matrix of personal interactions. As such, it will remain vulnerable to human failings, and the issue of integrity will always be central to the scientific culture.

Scientists and scientific administrators are constantly grappling with these questions,⁴⁹ along with conflict-of-interest issues related to the increasingly complex partnering arrangements involving domestic and foreign industries, universities, and domestic and foreign government agencies. Their discussions have been difficult and rancorous at times, but at no point has integrity been questioned simply because of the subject matter of the research in question. But that is exactly what transpired during this set of hearings.

It hardly seems coincidental that allegations concerning the conduct of research and the application of its results were directed only at research which supported policy options inimical to the Majority's point of view. The fact that none of the charges were remotely substantiated does not seem to have moderated either the rhetoric or the budgetary and policy choices selected by the Majority. The only logical conclusion that one can draw from these events is that certain types

⁴⁹ The latest and one of the most extensive overviews of scientific integrity is currently being conducted by the Office of Science and Technology Policy in the White House.

of research, and associated applications, were guilty of lapses of integrity simply because they led to unpopular conclusions. Were this attitude to become prevalent in the Congress, the stifling effect that it would have on free and open inquiry is at once obvious and frightening.

H. The Subcommittee has Highlighted a New and Very Unhelpful Paradigm for Scientific Productivity

As described earlier, a pervasive theme in these hearings was that scientific truth is much more likely to be found at the fringes than in the scientific mainstream. Historical anecdotes in which the mainstream was in fact proven wrong and the dissenters correct were often cited to justify an air of contempt towards the peer review process, the scientific consensus and the traditional scientific method.⁵⁰

As the scientific fringe has become institutionalized, professionalized, and lionized, it behooves us to take a closer look at its methods and beliefs. One finds that a fundamental difference between the traditional scientific establishment and the emerging "skeptical" establishment relates to their ultimate scientific goals. The former has traditionally emphasized the *generation of new knowledge* as a measure of productivity. That is, the collection of original data, construction of new mathematical techniques, and generation and validation of testable hypotheses have been the hallmarks of the traditional scientific community, and funding has been directly related to the ability to achieve these ends. On the other hand, the emerging culture profiled in these hearings emphasizes the *generation of new perspectives*. Productivity is measured on the ability to alter public opinion - through opinion pieces aimed not at their fellow scientists but at policymakers, the media, and the general public - and funding flows accordingly.

If funding sources for environmental R&D do tilt increasingly away from government sources and toward private sources, there will be an increasing risk that this new paradigm for productivity will become widely established.

V. Recommendations for the Scientific Community and the Congress

A. Lessons for Congress and an Agenda for the 105th Congress

⁵⁰ For the most part these anecdotes were inaccurate. For example, Galileo's view was not aimed at upsetting mainstream science, it was aimed at the dogma established by the religious and political hierarchy. It can be argued that the global warming premise, in fact, represents the Galileo tradition since it aims to establish that mankind **can** in fact upset a major natural system such as the climate. It cannot be said that this has been a pre-existing, generally accepted scientific belief.

The previous section of this report details a number of threats that these hearings posed to science, science policy, and environmental policy. With the convening of the 105th Congress, the Committee should resolve to be alert to these threats and to take seriously one of its most important functions - to educate other Members and the public about the function of the peer review process in ensuring objective and high-quality science. The Committee should also educate policymakers about the proper linkages between science and policy, neither imposing impossible burdens upon science, nor promoting for the Congress a role in arbitrating sound science.

A key lesson from these hearings relates less to what was discussed than to what was not discussed - how to deal with a range of value judgments that must be rationalized in a compatible policy framework. In particular, the climate change debate has illustrated three distinct viewpoints that represent equally valid value judgments regarding how science and policy can be rationalized. Each viewpoint in effect represents a differing judgment about one's willingness to be wrong:

1. Someone who places the highest value on protecting the environment is more likely to be willing to act now to prevent harm and to take the chance that such actions will later turn out to have been unnecessary as further scientific information becomes available. In such a case, the actor is willing to risk incurring the costs of unnecessary action as the price for ensuring that harm is avoided. A high level of scientific certainty is not required for such a policy position. In other words, the value that one places on protecting the environment justifies the purchase of an "insurance policy" even if the probability of the event is uncertain.
2. On the other hand, one who places a higher value on economic issues, such as the dependency of the world's social and economic balance on fossil fuel availability, is more likely to wait and take the chance that the possible harm does not occur. This view implicitly states that it is more important to avoid the costs of unnecessary action than to prevent an uncertain harm. A high level of scientific certainty would be required under such a policy perspective to justify the economic costs. In effect, such a policy position states that it isn't worth it to purchase an insurance policy unless the risks are very certain and very high.
3. Finally, a third policy perspective that values "sustainability" posits that economic and environmental interests are compatible and can be accommodated within a common policy framework. Such a perspective attempts to value both economic and environmental goals and to find ways in which they both can be protected and preserved.

Although the hearings touched on these value judgments and policy issues only peripherally, the economic impact of phasing out chemical products that have demonstrably improved our quality of life, of transitioning to new energy sources that may upset the world's socio-political balance, and of confronting subtle health hazards that may have been overlooked in the past represent real concerns. The ethical and social issues associated with man's impact on the environment underlie some of the most important decisions we will make in this generation. The backdrop against which this debate will unfold is an emerging scientific capability to understand what was previously unintelligible, calculate what was previously beyond the state of the art, and generate new technologies for which the benefits can only be imagined.

These are not issues of integrity - that is a profoundly unjustified oversimplification. These are issues which the Congress, the public, and the world community must openly and honestly debate. At present there does not even exist a forum or mechanism for carrying out this debate. The 105th Congress will have an opportunity to contribute to this debate. The hearing process, despite its inherent drawbacks, remains a valuable avenue for promoting this discourse. It is recommended that the Committee address the need to more clearly frame the linkage between science and decision making in the public interest. Such hearings will be an enduring contribution to the policy process.

B. Financial Disclosure as an Imperative for Scientific Integrity

Throughout the hearings, various witnesses were represented as experts. Published reports have documented that some of these witnesses are funded, at least in part, by corporate interests with a stake in the outcome of the debate. Although this latter fact does not necessarily affect the credibility of opinions expressed or the qualifications of the witnesses to make them, the Committee had little information at the time of these hearings with which to make such a judgment.

Emerging trends in science funding dictate that some safeguards be established to ensure the integrity of any scientific advice that is offered to Congress. First, expert witnesses should be required to provide a list of publications in their area of expertise, including both peer-reviewed and so-called "gray" publications. Secondly, sponsorship of scientific results and opinions offered to Congress is relevant. In these cases, the Committee should require, as a condition of presenting testimony, that witnesses provide a statement of financial support.

C. A New Responsibility for the Science Community

The scientific community must take seriously the challenge represented by the environmental critics by: (1) scrupulously ensuring that scientific assessments are open to all scientifically credible views; (2) educating policymakers on the role of scientific peer review in ensuring integrity and quality, and (3) educating the public and policy-makers with clear and cogent responses to scientific and technical criticisms raised by "skeptic" scientists.

Over the past several years the nature of the "skeptic" has changed dramatically. No longer are scientific debates confined to the traditional academic seminars, professional scientific meetings, and technical journals. They have spilled over into the newspapers, talk shows, and other public fora. And the traditional burden of proof has shifted. Rather than the author proving that an idea is worthwhile and should be published, others will have the burden of proving that a published statement or idea is not meritorious. In short, peer review is no longer a passive activity for the science community.

The emerging responsibility for the scientific community that these trends suggest is based not on scientific imperative, but on civic duty. That is, the science community must directly and actively rebut any inaccurate, misleading, or distorted scientific claims which are made in the public arena.

All too often, the science community has taken the position that the charges of these "skeptics" are so lacking in legitimate scientific underpinning that they do not merit attention. As a result, there is an insufficient public record to dispute these charges. Lack of peer review, lack of participation in the scientific process, and lack of technically sound arguments do not, of themselves, disqualify the skeptics from commanding public and Congressional attention.

The findings of this report suggest that an adequate rebuttal to these charges simply cannot be made effectively within the rapid-fire political process in which Congressional oversight is carried out. The scientific community must develop new mechanisms to engage these arguments as a general and ongoing task, not one that is carried out once or twice a year in a hearing. While this may disrupt or slow the traditional scientific process, it is seemingly an inevitable step. It is recognized that this requires an inordinate amount of time and energy on the part of the science community. There is little reward either scientifically or professionally. It is an unfortunate diversion. Yet this becomes an imperative in order to restructure the proper relationship between science and policymaking.

APPENDIX

Case Studies: Ozone Depletion, Climate Change, and Dioxin Risks

A Report to the Honorable George E. Brown, Jr. Ranking Democratic Member, Committee on Science prepared by the Democratic Staff of the Committee on Science

A. THE OZONE HEARING

The first of the "case study" hearings, relating to the 1992 Bush Administration decision to accelerate the phase-out of chlorofluorocarbons (CFCs) and other ozone-depleting substances, was held on September 20, 1995.

In his opening statement, the Chairman questioned whether the public and the Congress were "getting objective science from our regulatory agencies" and whether scientists with "unconventional views" were being "shut out of the process." He charged that government officials had portrayed the ozone depletion issue in "largely emotional terms" and decried the use of "scare tactics" designed to "intimidate and repress rational discussion." As an example, he cited a 1992 Senate floor statement made by then-Senator Gore concerning a just-released NASA study finding possible ozone depletion in the Arctic and portions of the northern United States. Dismissing Senator Gore's statement as "bunk" and "scare-mongering," the Chairman concluded that "This whole episode ... turned out to be another basically "the-sky-is-falling cry from an American Chicken Little..." He accused the "scare mongers" of "stamped[ing] Congress and the President of the United States" into phasing out CFCs.

Other witnesses quickly picked up similar themes. Rep. John T. Doolittle (R-CA) complained, "Instead of responding with scientific facts, some NASA scientists, EPA officials, and extreme environmental organizations have forced this imminent CFC phase-out on the American people using fear and doomsaying."¹ He went on, "[W]e've been in an era of pseudo-science where dire consequences are portrayed in order to achieve a certain political objective."² Dr. Fred Singer, one of the scientists called by the Majority, testified that, "There are cases where the science was twisted, shaped, in order to gain certain ideological objectives. There was never a case where the actual facts were, shall we say, misstated, where there was actual wrong information presented.

¹ *Scientific Integrity and the Public Trust: The Science Behind Federal Policies and Mandates: Case Study 1 - Stratospheric Ozone: Myths and Realities*, Hearing Before the Subcommittee on Energy and Environment of the House Committee on Science, 104th Cong., 1st Sess., No. 31 (September 20, 1995), at 15. (Hereinafter cited as "Ozone Hearing.")

² *Id.* at 19.

But it was presented in such a way as to give a misleading impression. You... are being today misled, bamboozled, and otherwise manipulated."³

Witnesses also charged that dissenting scientific views had been suppressed. Rep. Doolittle, for example, stated that, "There's politics within the scientific community, where they're all intimidated to speak out once someone has staked out a position."⁴ Dr. Singer noted, "The problem is that there are many, many scientists who do not speak up. And the reason they do not speak up is because they do not want to lose their research funding."⁵ Dr. Singer also claimed that his work had been ignored.⁶ Dr. Sallie Baliunas, another scientist called by the Majority, also alleged that she had been badgered by an environmental group and told by Federal officials not to submit her research for funding grants.⁷

As discussed below, however, the hearing record is in fact devoid of any credible substantiation for these serious allegations. To the contrary, the science upon which the CFC ban was based is sound. In developing an assessment of ozone depletion science for policymakers, hundreds of scientists went through an extensive, rigorous, and open international scientific peer review process. The assessment drew on hundreds of articles published in the peer-reviewed scientific literature and represents a comprehensive and objective analysis of the scientific knowledge on ozone depletion. Contrary to the witnesses' claims, the scientific assessment process was a model of scientific integrity and an excellent example of the use of sound science in policymaking.

Did Federal Scientists Exaggerate the Risks of Ozone Depletion?

1. The NASA Press Release Allegations

Both the Subcommittee Chairman and Rep. Doolittle charged during the hearing that a flawed NASA study was used to "stampede" Congress and the President in 1992 to accelerate the phase-out of CFCs. The story is a common staple in conservative literature.⁸ The story goes that NASA, in a public relations effort to

³ *Id.* at 50.

⁴ *Id.* at 19.

⁵ *Id.* at 168.

⁶ *Id.* at 167.

⁷ *Id.* at 169.

⁸ See, e.g. "The Ozone Scare," *Insight*, Vol. 8, No. 14 (April 6, 1992), pp. 6-35 [a publication of the *Washington Times*]; Smith, Kenneth, "Whispering the Ozone Hole Truth", *Washington Times*, May 18, 1992; Michaels, Patrick, "NASA, Gore, Environment, Lift-off", *Washington Times*, February 21, 1992, Page F1; Ronald Bailey, *Eco-Scam: The False Prophets of Ecological Apocalypse* (Washington: Competitive Enterprise Institute, 1993), pp. 119-120; Bast *et al.*, *Eco-Sanity: A Common Sense Guide to Environmentalism* (Palatine, IL: The Heartland Institute, 1994), p. 67; Paul Craig Roberts, "Quietly, Now, Let's Rethink the Ozone Apocalypse," *Business Week*, June 19, 1995.

(continued)

build political support for a bigger budget, prematurely rushed out a press release announcing evidence of an Arctic ozone hole covering portions of populated areas of the United States.⁹ Fanned by intense media coverage, Congress and the White House immediately accelerated the CFC phaseout. However, the story continues, the NASA report turned out to be wrong, and NASA quietly admitted that there had in fact been no ozone hole - and therefore no basis for accelerating the CFC phaseout. This story has long been cited by critics as a prime example of "policy by press release."¹⁰

The story, however, is completely false. There was nothing wrong with the scientific findings announced in NASA's press release; there was no retraction. Indeed, NASA's predictions of future Arctic stratospheric ozone depletion has proved to be correct. Further, NASA's press release had little, if any, relation to the decision, supported by both the Bush Administration and the chemical industry, to accelerate the CFC phaseout.

Much of the initial pseudo-scientific skepticism about the depletion of the ozone layer by CFCs comes from Rogelio Maduro, a bachelor of science in geology, and associate editor of *21st Century Science and Technology*, a publication of the Lyndon LaRouche organization. Maduro's book, *The Holes in the Ozone Scare: The Scientific Evidence that the Sky Isn't Falling*, was cited by Dixy Lee Ray in her book, *Trashing the Planet*, and by radio talk show commentator Rush Limbaugh. The numerous scientific errors in Maduro's book have been well documented. See, e.g. Taubes, Gary, "The Ozone Backlash," *Science*, **260**, 1993, pp. 1580-1583; F. Sherwood Rowland, "The Need for Scientific Communication with the Public," *Science*, **260**, 1993, pp. 1571-1576.

⁹ Critics have claimed that concern about shrinking budgets and declining public support for the space program in the post Cold War era was the motivating factor in NASA's "premature" release of the study to support its budget request. See, e.g. Morrison, Micah, "The Ozone Scare," Note 8 *supra*, pp. 13, 34; Michaels, "NASA, Gore, Environment, Lift-off," Note 8 *supra*, p. F2. As Rush Limbaugh explained, "They always want more funding, and today that means government funding. What could be more natural than for... [NASA], with the space program winding down, to say that because we have this unusual amount of chlorine in the atmosphere we need funding? Obviously, we have to research this. But first we have to 'inform' the public." Quoted from Taubes, "The Ozone Backlash," Note 8, *supra*, at 1581.

The argument that the press release was rushed to influence NASA's budget is not plausible. While the President's budget is submitted to Congress in February, the budget process lasts virtually all year long. The House does not actually begin voting on appropriation bills until May at the earliest, and bills are often not completed until September or longer - well after NASA had issued the second press release on its ozone study, as discussed in the text. Indeed, it is difficult to find a time of year when any press release could not be accused of being an attempt to build public support for a budget request. A release in the fall could be accused of attempting to influence the OMB preparation of the following year's budget; a release in the winter or spring could be accused of influencing Congressional mark-ups; and a release in the summer can be accused of attempting to influence Congressional floor debate.

In any event, attempting to bolster NASA's budget by publicizing its ozone research is like trying to lighten an airplane by emptying the ashtrays. Far and away, the largest part of NASA's budget deals with the space shuttle (\$5.5 billion) and the space station (\$2.1 billion); NASA's ozone research is a relatively small program in the agency.

¹⁰ See, e.g., testimony of Dr. Singer, Ozone Hearing, *supra*, at 181, lamenting the "deplorable way in which policy is being made by press release."

a. Was NASA's science wrong?

In early February, 1992, NASA issued a press release announcing that researchers had measured record high levels of the chemical precursors of stratospheric ozone depletion in the Arctic region.¹¹ NASA's key finding - that levels of stratospheric chlorine monoxide were unusually high - was confirmed by multiple measurement techniques. Under the right meteorological conditions, such chemicals could cause rapid ozone depletion in the Arctic region, reaching as far south as northern portions of the United States. But the NASA release also cautioned that the actual amount of ozone loss would depend on "how long these chemical perturbations persist." Nevertheless, the study raises "concern that significant ozone loss will occur during any given winter over the Arctic in the next ten years." In April, at the conclusion of the research program, NASA issued a second press release announcing that because stratospheric temperatures had remained above normal, the expected extent of ozone depletion had failed to materialize.¹² But nothing in this later release changed NASA's key initial finding that the Arctic was chemically primed for rapid ozone depletion under the right meteorological conditions.¹³

More significantly, NASA's concern about the potential for Arctic ozone depletion has turned out to be well-founded. In the following winter of 1992-1993, stratospheric temperatures remained low, with a resulting 20 percent decline in ozone in the lower Arctic stratosphere.¹⁴ Similar levels of ozone depletion were detected in the winters of 1994-1995 and 1995-1996.¹⁵ Based on these and

¹¹ NASA News, "Ozone Depletion a Possibility Over Northern Populated Areas", February 3, 1992.

¹² NASA News, "NASA Spacecraft Finds Large Arctic Ozone Depletion Averted," April 30, 1992.

¹³ A number of media stories erroneously reported that NASA had actually found an Arctic ozone hole. Some critics seem to blame scientists for the mistakes and excesses of the media. Scientists, they argue, hope that the media will generate exaggerated horror stories that will build public support for their programs. For example, on this particular NASA press release, Dr. Michaels has written, "Do you really believe that an organization that sent men to the Moon didn't precalculate the downstream trajectory of a press release?" Michaels, "NASA, Gore, Environment, Lift-off," Note 9, *supra*. Similarly, Dr. Michaels testified in the global change hearing that scientists knew that various "projections" of adverse impacts of climate change, such as sea level change, would be turned into apocalyptic "predictions" by the media. "[E]verybody who wrote the word 'projection' knew that it would be turned into the word 'prediction.' I don't think people are that naive." Global Climate Change Hearing, *supra*, at 76.

¹⁴ "Chemical Depletion of Ozone in the Arctic Lower Stratosphere during Winter 1992-1993," G.L. Manney *et al.*, *Nature*, **370**, 1994, pp. 429-434.

¹⁵ The National Oceanic and Atmospheric Administration reported that total column ozone levels in the middle and high latitudes of the Northern Hemisphere were 10 to 20 percent lower than values observed in the late 1970s and early 1980s, and that ozone levels were up to 35 percent lower in some high latitude regions. NOAA, "Northern Hemisphere Winter Summary 95/1" (April 1995). The 1995-96 winter report found unusually low levels of ozone over portions of Northern Europe and concluded that total ozone depletion over the Northern hemisphere mid-latitudes has proceeded at an annual rate of about 4 percent since 1979. NOAA, "Northern Hemisphere Winter Summary 1995-96" (April, 1996)

other studies, the 1994 Scientific Assessment of Ozone Depletion concluded that "ozone losses have been detected in the Arctic winter stratosphere, and their links to halogen chemistry have been established."¹⁶

b. Did Congress and the White House rush to judgment on faulty science?

The decision to accelerate the phase-out of CFCs had little or nothing to do with the NASA press release.

On April 9, 1991, ten months before the NASA study release, Senator Gore introduced S. Res. 95, a non-binding Senate resolution calling for the acceleration of the scheduled phase-out of CFCs.¹⁷ In his remarks, Senator Gore referred to recent scientific studies showing stratospheric ozone depletion at mid-latitudes occurring at even greater rates than had been predicted by models. He also noted that the European Community had already agreed to completely phase out CFCs by 1997, three years earlier than required by the London Agreement. Seven months later, and several months before the NASA press release, the Senate Foreign Relations Committee reported S. Res. 95 with an amendment that, among other things, called for the phaseout of CFCs only "as early as possible" instead of specifying a specific deadline.

Following the release of the NASA study, on February 6, 1992, Senators Gore and Chafee offered the reported resolution as an amendment to a pending bill. Senator Gore referred to the new NASA study only as further proof of the vulnerability of the stratospheric ozone layer to manmade chemicals. As Senator Mitchell stated during the debate:

"We confront the prospect of extraordinary and potentially very dangerous damage to the ozone layer over densely populated areas in our own country. We have known about this for some time. The recent NASA report is merely confirming evidence of what we have known previously in a more dramatic manner, but it is not new evidence. It is cumulative evidence on top of that which we have had for some time."¹⁸

With the support of the Bush Administration, the resolution passed 96-0.

¹⁶ World Meteorological Organization, *Scientific Assessment of Ozone: 1994*, Global Ozone Research and Monitoring Project - Report No. 37, Geneva, 1995.

¹⁷ S. Res. 95 (102nd Congress), introduced with 16 initial cosponsors, called for an acceleration of the CFC phaseout to 1997. S. Res. 95 required EPA, pursuant to its existing authority under the Clean Air Act Amendments of 1990, to accelerate the phase out of CFC production and to provide for recapture and recycling of CFC and other ozone-destroying chemicals, and calling on the President to urge the contracting parties to the Montreal Protocol to strengthen the existing accord.

¹⁸ 138 *Cong. Rec.*, S113 (February 6, 1992).

A week later, on February 11, 1992, the Alliance for Responsible Atmospheric Policy, a coalition of 250 chemical industry manufacturers and users, filed a petition with the EPA to accelerate the phase-out of CFCs by the end of 1995. The Alliance filed the petition "in acknowledgment of substantial technological advances as well as in response to announcements over the last year concerning additional measurements of ozone depletion around the globe." The accelerated phaseout was made possible because of industry progress in developing ozone protective CFC replacement technologies.¹⁹

On the same day, the Bush Administration announced its intention to accelerate the complete phaseout of CFCs by 1995. A meeting of the parties to the Montreal Protocol was convened in Copenhagen in November, 1992, and agreed to modifications to provide for an accelerated phaseout of CFCs consistent with the Bush Administration position. The Copenhagen accords were ratified by the Senate in the subsequent Congress, on November 20, 1993, *twenty-one months after the NASA report was released*.

What was the impact of the February, 1992, NASA report on this 2-1/2 year process? Kevin Fay, testifying on behalf of the Alliance for Responsible Atmospheric Policy, a coalition of U.S. chemical manufacturers and CFC users, stated plainly: "I can state without any doubt, as one who has lived throughout this entire 20-year process on this, the acceleration of the phase-out of CFCs in 1992 had nothing to do with the February, 1992 press conference by NASA."²⁰

Dr. Robert Watson, who was a chief scientist at NASA at the time, agreed. "I'm quite convinced [that President Bush did not] look at the NASA press release. Alan Bromley was his science advisor at the time and Alan Bromley took advice from a large number of people and discounted that press release."²¹ He added, "The reasons that the Copenhagen amendments were so forcefully pushed through [the international community] - who don't care about NASA press statements - and within the Senate, was they observed that we by now had seen global ozone depletion at all seasons, except for the tropics. And it was that information that pushed the amendments to the Montreal Protocol."

2. Allegations Concerning EPA's Cost-Benefit Analysis

Members and witnesses were also highly critical of EPA's cost-benefit analysis, which indicated that the costs of phasing out CFCs were far outweighed by the risks of ozone depletion, including increased incidences of skin cancer. Members and witnesses testified, for example, that new research has indicated that UV-B radiation does not cause fatal melanomas, and that EPA's risk

¹⁹ Ozone Hearing, *supra*, Attachment 2 to testimony of Kevin Fay, at 217.

²⁰ *Id.*, at 203.

²¹ *Id.* at 181.

estimate was therefore "flawed" and the risks "grossly overstated".²² Pointing to natural variability in UV-B radiation, witnesses stated that the increased UV-B would be no worse than moving 60 miles south.²³ Further, witnesses argued that EPA failed to consider negative health effects caused by the CFC phaseout, such as increased incidence of heat-associated deaths.²⁴

Again, the record failed to substantiate these allegations of a distorted cost-benefit analysis. In considering the accelerated phaseout of CFCs, EPA extensively examined the costs of a CFC phaseout. While recent research, not available when EPA conducted its cost-benefit analysis, raises new uncertainties about the relationship between increased UV-B and melanoma skin cancers, EPA estimates that the costs of the CFC phaseout are still greatly outweighed by the benefits even if melanoma skin cancers were excluded as one of the risks. These issues are examined in more detail below.

a. Was EPA's cost-benefit analysis wrong about UV-B causing skin cancer?

EPA carried out cost-benefit analyses in 1990 (to phase CFCs out by 2000) and in 1992 (to accelerate the phase out to 1996). In conducting the cost-benefit analysis, EPA extensively consulted with industry on questions of cost and solicited public comments on its studies and inputs and comments from others.²⁵

As in many other areas of human health, the relationship between UV-B radiation (which would increase at ground level if the stratospheric ozone layer were diminished) and melanoma skin cancer is complex. Recent work with fish by Dr. Richard Setlow suggests that UV-A radiation, which would not be affected by ozone depletion, is the principal cause of melanoma skin cancers, and that the role of UV-B is minimal.²⁶ However, Dr. Margaret Kripke, who testified along with

²² See, e.g., statement of Hon. John Doolittle, *id.*, at 13-14. An agency can only base its rules on the best science available at the time. Scientific knowledge, of course, can change over time, and agencies should reexamine rules if the science on which they are based subsequently appears to be in error. In the present case, as discussed in the text, the phaseout of CFCs appears justified even if melanoma cancers are excluded from a risk/benefit analysis.

²³ "[T]he increased risk of skin cancer that one would face without the ban is equivalent to moving 60 miles closer to the equator, for instance, from Washington, D.C. to Richmond, VA." Rep. Doolittle, *id.*, at 15; see also the panel discussion at 179-180.

²⁴ See, e.g., testimony of Ben Lieberman, Competitive Enterprise Institute, *id.*, at 226; Dr. Richard L. Stroup, Policy Economy Research Center, *id.*, at 263.

²⁵ See testimony of Mary D. Nichols, U.S. EPA, *id.*, at 192 *et seq.*

²⁶ See testimony of Dr. Richard Setlow, *id.*, at 133 *et seq.* As with all experiments conducted on animals, there are questions about extrapolating these findings to humans, as Dr. Setlow recognized. "The big uncertainty lies not in the data on fish, but on whether it's valid to extrapolate. This is a big biological problem. [C]ancer depends on lots of steps about which we have limited knowledge." *Id.*, at 134.

Dr. Setlow, stated that other preliminary scientific work continues to suggest a role of UV-B in the development of some melanoma skin cancers.²⁷

On the other hand, it is undisputed that UV-B exposure is responsible for nonmelanoma skin cancers. While some critics have stated that nonmelanoma skin cancer is not a serious health problem, since most can be cured with early treatment, Dr. Kripke noted that there are many cases where nonmelanomas are aggressive and lethal even where there is an early intervention.²⁸ Nearly one-quarter of all of the skin cancer deaths in the United States are from nonmelanoma skin cancers.²⁹ Further, nonmelanoma cancers can be extremely disfiguring, with significant economic and psychological costs. EPA noted that over 85% of the quantified health benefits of the CFC phaseout come from avoiding nonmelanoma cancers and other undisputed effects of UV-B radiation, such as cataracts.³⁰ Dr. Kripke also testified that ongoing work suggests a link between UVB exposure and damage to the human immune system, although such effects cannot be quantified at this time.³¹

The expected increased incidences of cataracts and nonmelanoma skin cancer from increased UV-B radiation is so large that their costs overwhelm the costs of phasing out CFCs. EPA estimated that the benefits of the CFC phaseout exceeded the costs by a factor of up to 700 to 1. Since melanoma cancer accounted for only 15% of the quantified health costs, even eliminating melanoma from the calculations altogether has a negligible effect on the benefit-cost ratio.³²

Nevertheless, several witnesses claimed that the increased health risk caused by a projected 5 to 10 percent decline in the ozone layer was trivial, since such changes are smaller than the natural variations in UV-B exposure by latitude.³³

²⁷ Testimony of Dr. Margaret Kripke, *id.*, at 146. See also the statement of Dr. Rex A. Amonette, President, American Academy of Dermatology, included in the record. *Id.*, at 7 *et seq.*

²⁸ *Id.*, at 178.

²⁹ Statement of Dr. Amonette, Note 27, *supra*, at 7. "This year, nearly 1.2 million Americans will be diagnosed with non-melanoma skin cancer.... Although highly curable if detected and treated early, nearly 10,000 Americans will die of skin cancer this year - about 7,500 from malignant melanoma and the rest from non-melanoma skin cancers."

³⁰ Nichols, Note 25, *supra*, at 195.

³¹ Ozone Hearing, *supra*, at 148 *et seq.*

³² Mary Nichols testified that the total public health benefits of the CFC phaseout from avoided cases of skin cancer, cataracts and other health effects were between \$8 and \$32 trillion (depending on the assumed value of life) over the period of 1989 to 2075, while the costs of the phaseout were calculated as about \$46 billion over the same period. *Id.*, at 197.

³³ See, e.g. testimony of Rep. Doolittle, stating that the increased UV-B radiation from ozone depletion is no greater than the increased natural radiation one would get by moving 60 miles towards the equator. Note 23, *supra*. Dr. Singer also noted that UV-B radiation was 200% higher in Florida, and that "if the effects were really devastating... I would expect to see all kinds of epidemics in Florida, people whose immune systems were collapsing." Ozone Hearing, *supra*, at 158. In fact, there is little question that people living in lower latitudes have significantly higher skin cancer rates. As Dr. Setlow noted, "Nonmelanoma in Australia is about 20-fold greater than (continued)"

While it is true that annual cumulative exposures to UV-B differ naturally by latitude, most of the difference between northern and southern latitudes occurs during the winter when exposure to sunlight is the lowest. In the summer, however, when people are outside and their skin is directly exposed to sunlight, there is much less difference in the UV-B exposure between northern and southern U.S. latitudes. Further, a diminishing ozone layer simply increases UV-B exposure in all latitudes above and beyond natural variability, ensuring higher exposures and greater incidences of skin cancer. Finally, as Dr. Watson made clear, the projected ozone losses would not have stopped at a 7 percent decline over midlatitudes. "Without the Montreal Protocol," Dr. Watson stated, "we would probably in the future be looking at ozone depletions of 10, 20, even 30 percent."³⁴ Scientists estimate that each 1 percent decrease in stratospheric ozone would lead to a 2 percent increase in skin cancers.³⁵

b. Did EPA fail to consider costs?

Ben Leiberman of the Competitive Enterprise Institute (CEI) charged in his testimony that EPA had "largely ignored" the costs of phasing out CFCs.³⁶ In fact, EPA extensively considered costs in its regulatory impact analysis conducted in 1990 and again in 1992. Kevin Fay flatly contradicted the CEI statement:

"The charge made by some, however, that the impact on consumers was 'scarcely considered,' is not accurate. The fact is that industry actions have been guided by unprecedented concern by the affected industries for the costs on their customers, and of the health, safety, and welfare of the users of the existing and substitute technologies."³⁷

Nevertheless, both Mr. Leiberman and Dr. Stroup (an economist at the Policy Economy Research Center) charged that the increased cost of CFCs would make refrigeration and cooling more expensive and therefore less available, leading to increases in food poisoning and stomach cancers³⁸ and deaths from

in Norway, a tremendous difference." *Id.*, at 159. However, most scientists believe that the current increase in skin cancers is due more to lifestyles that increase sun exposure rather than increased radiation from the depleted ozone layer, since cancer is caused by chronic sun exposure over many years. *Id.*, at 180.

³⁴ *Id.*, at 180.

³⁵ "For each 1% depletion of ozone, the rate of squamous cell carcinoma is expected to increase by 2%-5%, and the rate of basal cell carcinoma by 1%-3%." Amonette, *id.*, at 10. See also testimony of Dr. Kripke, *id.*, at 150: "The latest estimates indicate that for a 1% reduction in ozone, the incidence of non-melanoma skin cancer will increase by 2.0 + 0.5%."

³⁶ *Id.*, at 241.

³⁷ *Id.*, at 212.

³⁸ Stroup testimony, *id.*, at 267, 270.

heat stress.³⁹ On questioning, however, both Mr. Lieberman and Dr. Stroup agreed that such effects were entirely "hypothetical."⁴⁰ In fact, Dr. Stroup conceded that the price of refrigeration was actually coming down and consumer choice was increasing.⁴¹ Kevin Fay responded "[T]o somehow link the deaths [to the CFC phaseout], as [Mr. Lieberman] tried to do recently in his op-ed piece, the deaths in the Chicago heatwave, is shocking in its irresponsibility."⁴²

3. Did Scientists Exaggerate the Depletion of the Ozone Layer?

Dr. Singer testified that "the history of the CFC-ozone depletion issue is rife with examples of the breakdown of scientific integrity: selective use of data, faulty application of statistics, disregard of contrary evidence, and other scientific distortions."⁴³ Drawing from reports she authored for the George C. Marshall Institute,⁴⁴ Dr. Baliunas testified, for example, that there was in fact no evidence of a long-term decline in stratospheric ozone. According to Dr. Baliunas, any downward trend identified in stratospheric ozone levels is an artifact of selecting the beginning and end points of the data. A downward trend can be shown beginning in 1970 solely because 1970 is the highest ozone level in the 34-year record.⁴⁵ If other beginning and end points were selected, she testified, no trend could be observed.

However, Dr. Daniel Albritton and Dr. Watson testified that Dr. Baliunas and Dr. Singer were simply wrong. The data were closely examined through a "sensitivity analysis" to see if the selection of starting and ending points would have any impact on the trend. The result was that the sensitivity to the starting date is small: "You broadly get the same effect, whether you start in 1965 or 1975."⁴⁶ Dr. Albritton observed that the sensitivity of the starting date is small

³⁹ Lieberman, Ben, "EPA Regulations That Can Kill," *Washington Times*, August 24, 1995, p. A19.

⁴⁰ Ozone Hearing, *supra*, at 288, 289. In responding to questions about the *Washington Times* article, where he linked 600 deaths in a Chicago heat wave to the unavailability of air conditioning, Lieberman stated that he had been "very careful" to say that "there's no evidence that anyone was actually hurt. But the possibility cannot be discounted. I'm just theoretically saying that, in broad terms, if you make air-conditioning more expensive, you will make it less available."

⁴¹ *Id.*, at 288.

⁴² *Id.*, at 203.

⁴³ *Id.*, at 58. See also testimony of Dr. Singer, at 175.

⁴⁴ Baliunas, Sallie, "The Ozone Crisis", (Washington: George C. Marshall Institute; 1994); Baliunas, Sallie, "Ozone & Global Warming: Are the Problems Real?", (Washington: George C. Marshall Institute; 1994).

⁴⁵ Testimony of Dr. Baliunas, Ozone Hearing, *supra*, at 129.

⁴⁶ Testimony of Dr. Robert Watson, *id.*, at 176, citing analysis carried out by scientists at Allied Signal, a major producer of CFCs at that time.

because the rate of decline in recent years has accelerated so quickly, consistent with CFC-ozone theory, that it overwhelms any early effects.⁴⁷

Dr. Baliunas presented a second claim to demonstrate that there had been no downward trend in ozone levels. A chart in her testimony shows the natural variability in ozone levels, where trends are not readily observable.⁴⁸ But in responding to questions about the differences between her chart and the one in Dr. Watson's testimony taken from the report of the international assessment,⁴⁹ in which the downward trend is clearly observable, Dr. Baliunas readily admitted that there was no "real contradiction."⁵⁰ Unlike Dr. Baliunas' chart, which simply graphs raw data, the data graphed in Dr. Watson's chart were adjusted to remove known natural sources of ozone variability so that the relevant factor - the human influence on ozone depletion - could be measured.⁵¹ Nor did she dispute that either set of data showed a downward trend.⁵²

Finally, both Dr. Singer and Dr. Baliunas made much of the point that there is little evidence that levels of UV-B radiation on the ground are increasing, which would be expected if the ozone layer were actually thinning.⁵³ But as explained by Dr. Albritton, the lack of data is readily explained by the fact that it is exceedingly difficult to measure ground level UV-B trends because of the

⁴⁷ Albritton testified: "We had no single one starting point on the downward trend. We actually included the previous years as a baseline to determine that starting point. And that way you don't unduly weight it with any one starting point. In the report back on this, we examined the sensitivity of choosing the year in which the downward trend may have started. And it is a relatively small sensitivity because of the point that I mentioned: namely, we're fitting with a curve that looks very much like a hockey stick where there is a level period and then a linear trend. That decreases any weight on a starting point." *Id.*, at 172.

⁴⁸ *Id.*, at 131-132.

⁴⁹ *Id.*, at 45.

⁵⁰ "The data I show here in Chart 1 and Chart 2 have been corrected for the spring to fall seasonal change, but no other effect. It hasn't been corrected for the solar effect. It hasn't been corrected for the QBO [quasi-biannual oscillation], and it has not been corrected for any other volcano impact. Dr. Watson's chart I believe does correct for those. So there's no real contradiction. It's just that he's charting it to show the trend. I was showing some of the natural variability. So two different aspects." *Id.*, at 183.

⁵¹ "What the scientists wanted to portray in my Figure 4... was to try to show what were the effects of human interactions on the ozone there. They took the ozone record from both satellite and ground-based stations and they then took out seasonal fluctuations. They took out the effect of what we call the quasi-biannual oscillation.... So you could take out the natural effects on the ozone there. What you have left is that trend and what one can clearly see, there was approximately a 5-percent ozone depletion between 1979 and 1994.... [W]e try to get the information most relevant to policymakers. We try to separate out the long-term trend. That has nothing to do with natural variability." Dr. Robert Watson, *id.*, at 184.

⁵² "Well, if you look at the percent change, my Chart 1, which is that same as Chart 2, I still have a lot of natural variability, but there is a trend in the latter part of the data that would be reflected in his." Dr. Baliunas, *id.*, at 183.

⁵³ See, e.g., *id.*, at 51, 56-57. It is not clear whether this argument is intended to prove that the stratospheric ozone layer is not thinning, or instead that the risks from increased UV-B radiation have been overstated because some unspecified mechanism blocks the radiation from reaching the ground.

interference of clouds, weather, and pollution.⁵⁴ However, where these limitations have been overcome, numerous studies have demonstrated through direct measurements a clear correlation between decreased levels of stratospheric ozone and increased surface UV-B radiation.⁵⁵

4. Did Scientists Ignore or Suppress Dissenting Views?

As noted previously, witnesses and Members both charged that "mainstream" scientists ignored contrary data or suppressed dissenting views. Again, however, the record is devoid of credible substantiation for these serious charges.

When the CFC-ozone depletion theory was first propounded in the early 1970s, it challenged the conventional scientific wisdom. There was widespread skepticism about the theory in both scientific and industry circles. As Kevin Fay testified, the U.S. chemical industry launched a major research program in the hopes of disproving the theory.⁵⁶ As Dr. Watson also noted, other nations, such as the Soviet Union, were also highly skeptical and assigned some of their best statisticians to disprove the theories.⁵⁷ Over time, and as the theory survived rigorous testing, research, and peer review, skeptics became believers. As Dr. Watson noted about the process, "That's what I mean when, many times... the majority views have been challenged by the minority. They are now key players in the international assessment."

Despite the long history of research effort to disprove the ozone-CFC theory, Dr. Singer and others continue to claim that research challenging the CFC-ozone theory is suppressed. He noted, for example, that "In the case of ozone depletion work, my work has been ignored. My papers have been ignored and you will not find a reference to anything that I've published in here, no matter when it was published."⁵⁸ Dr. Albritton contradicted Dr. Singer's testimony: "I am confused by Dr. Singer's statement that his paper was ignored. His one paper that has been referred to, the [technical comment in *Science*], is referenced on page 9.21 of the current assessment. It also references the reply of the original authors about whom he was commenting. And so we had not only included the

⁵⁴ See, e.g. statement of Dr. Albritton, *id.*, at 87-88 and 170; Dr. Watson, at 157.

⁵⁵ *Ibid.*

⁵⁶ "In 1980 we believed that rigorous scientific analysis would eventually disprove what was then considered to be an unproved scientific theory.... In 1986, the comprehensive assessment of ozone science was released by NASA and the World Meteorological Organization (WMO). It was on the basis of the information contained in that assessment, information that industry experts had assisted in developing, that industry representatives came to the conclusion that the potential existed for serious and unacceptable future environmental risks, if CFC growth continued well into the next century." Statement of Kevin Fay, Alliance for Responsible Atmospheric Policy, Ozone Hearings, *id.*, at 207-208.

⁵⁷ *Id.*, at 168.

⁵⁸ *Id.*, at 167.

original paper. We included comments and discussion related to both sets of comments on that paper."⁵⁹

Dr. Singer also claimed, without providing specific substantiation, that other researchers skeptical of the ozone-CFC link were fearful that their funding would be jeopardized.⁶⁰ Such an extraordinary claim would seem to imply a coordinated international conspiracy among hundreds of scientific journals, universities, industries, and governments to suppress research. As Dr. Watson observed, the U.S. government is not the sole source of funding for research; funding also comes from industry and some "very conservative governments."⁶¹ Dr. Watson concluded "I do believe that through the international peer review process, and journals, I believe the minority of scientists have many, many avenues through which they can get their minority views to the public."⁶²

Perhaps the most sensational charge made at the hearing was leveled by Dr. Baliunas, who claimed that she had been directly told "by officers of Federal funding agencies not to apply for funding to work on 'certain questions' in this area. They gave two reasons. One is that answering these questions would undermine the possibility of getting new funds. And this suggests a complete breakdown of the peer review process.... In addition, answering these questions, or even investigating them, might deter policy-makers from, quote, doing the right thing."⁶³ She went on to allege that, "In fact, I've been badgered. My staff has been badgered in the last several days, my superiors, by an advocacy group, once the witness list came out. The employer that employs me is unrelated to this testimony. Nevertheless, they've been calling and calling and calling and badgering them, and this has had great effect. It's disrupted my work environment. It's an attempt to intimidate me and to censor my-."

Members on both sides of the aisle expressed concern about these serious allegations, as did Dr. Watson in his capacity at OSTP. At the same time, Members expressed concerns that such serious charges should be substantiated with specific information, providing names and dates.⁶⁴ Dr. Baliunas, in response to requests for specific information that the Committee could use to substantiate and investigate these allegations, agreed to provide specific information in writing to the Committee, and Chairman Rohrabacher promised an investigation.⁶⁵

⁵⁹ *Id.*, at 167-168.

⁶⁰ "[T]here are many, many scientists who do not speak up. And the reason they do not speak up is because they do not want to lose their research funding." *Id.*, at 168.

⁶¹ *Ibid.*

⁶² *Id.*, at 169.

⁶³ *Id.*, at 169.

⁶⁴ *Id.*, at 169, 185.

⁶⁵ *Id.*, at 185.

Dr. Baliunas subsequently provided a written response to the Committee, included in the appendix to the hearing record.⁶⁶ Dr. Baliunas' written response failed to contain the specific information requested by the Subcommittee, but stated only that these alleged statements had been made by an unnamed National Science Foundation official during a coffee-break conversation at a symposium. Dr. Baliunas further admitted that since she had never actually submitted such a research proposal for consideration, she could not say whether such a conversation would "actually" affect the proposal process.

Apparently, Dr. Baliunas informed the Subcommittee that she could not "name names" because of a fear of legal liability.⁶⁷ Without identifying the individual allegedly responsible for making these allegations, the Subcommittee failed to take any further steps to corroborate Dr. Baliunas' allegation that Federal officials threatened her funding or otherwise warned her against applying for funding.⁶⁸

Dr. Baliunas' written response also clarified her testimony that she had been intimidated by an environmental organization. According to her letter, Ozone Action, an environmental group, had contacted the Public Relations Office of the Harvard-Smithsonian Astrophysical Observatory to inquire if Dr. Baliunas was testifying on behalf of the Observatory as indicated on the Committee's witness list. In a later interview with Minority staff, the Public Affairs Director stated that he had appreciated the call and felt that it was entirely appropriate and did not constitute intimidation or harassment.⁶⁹ The other basis for Dr. Baliunas' charge of intimidation by Ozone Action was apparently based on a request by Ozone Action to review the public Form 990 tax forms of the George C. Marshall Institute. It is difficult to understand how such actions could reasonably be construed to constitute intimidation and harassment.

Dr. Baliunas took the opportunity in her letter to raise a new claim, stating that *Nature* had refused to publish an article which she had written and implying that the article was rejected for political reasons. In a response requested by Ranking Minority Member George Brown and also included in the record, *Nature* editor John Maddox disputed several of Dr. Baliunas' factual assertions and

⁶⁶ *Id.*, at 324 *et seq.*

⁶⁷ *Scientific Integrity and the Public Trust: The Science Behind Federal Policies and Mandates: Case Study 2 - Climate Models and Projections of Potential Impacts of Global Climate Change*, Hearing before the Subcommittee on Energy and Environment of the House Committee on Science, 104th Cong., 1st Sess., No. 35 (November 16, 1995), p. 5. (Hereinafter cited as "Global Climate Change Hearing"). Chairman Rohrabacher stated that "Dr. Baliunas made it very clear to this chairman that she had to go to a lawyer to make sure that she was not sued, and unless she could actually prove something in a private conversation, she could not make a public charge because she was personally liable." Rep. Rivers responded, "Truth is always a defense to libel."

⁶⁸ Despite this lack of substantiation, her charges have not only been repeated by as fact by Members, but grossly exaggerated. During a debate on the House floor, for example, Chairman Rohrabacher charged that Dr. Baliunas "had been threatened and had been told that she would not receive any more grants if she came to testify." 141 *Cong. Rec.*, H9945 (October 12, 1995).

⁶⁹ Interview with Mr. Jim Cornell, Feb. 12, 1996.

stated that the "decision to reject the paper was made on purely technical grounds, which the authors have never chosen to rebut."⁷⁰ Dr. Baliunas provided an additional response for the record, but it continues to fall short of substantiating her claim that her article was rejected for political, rather than technical, reasons.⁷¹

B. THE GLOBAL CLIMATE CHANGE HEARING

On November 16, 1995, the Subcommittee on Energy and Environment held its second hearing to examine lapses of scientific integrity in the Federal policymaking process. The hearing was focused on global climate change models and the extent to which they have been used as a basis to establish an international consensus on global warming that may arise from man-made emissions.

The tone of the hearing was antagonistic towards policies aimed at reducing CO₂ emissions and scientific research that appears to support such policies. This point of view was articulated in June, 1995 by the Subcommittee Chairman:

"Nowhere is scientific nonsense more evident than in global warming programs that are sprinkled throughout the current year budget... but there's a new gang in town.... Our '96 budget does not operate on the assumption that global warming is a proven phenomenon. In fact it is assumed that at best to be unproven and at worst to be liberal clap trap; trendy, but soon to go out of style in our Newt Congress."⁷²

Specific issues addressed in the hearing were:

- **Model Limitations** - The hearing focused on the inherent uncertainties in global warming models and the difficulties such models have had in reproducing past climatic trends. There was an attempt to illustrate that such models were an insufficient basis for making policy decisions, in part by citing a recent General Accounting Office study on this subject.
- **Inadequate Technical Basis for Impact Predictions** - The hearing attempted to illustrate that predictions of the impacts of global warming on sea level rise, disease incidence, and weather patterns did not directly derive from global circulation models and hence lacked a quantitative basis. The clear implication was that such impacts lacked a valid

⁷⁰ Ozone Hearing, *supra*, at 336 *et seq.*

⁷¹ *Id.*, at 343.

⁷² June 7 Press Conference preceding markup of Energy and Environment legislation.

scientific basis, could be subject to manipulative interpretation, and could emphasize political ends.

- **Global Warming Will Have Beneficial Effects** - The hearing provided a forum for making the case that warm periods in past history have been associated with flourishing societies and, hence, global warming will have beneficial effects if it occurs.
- **Failure of the Peer Review Process** - This hearing aimed to illustrate that the peer review process utilized by the Intergovernmental Panel on Climate Change (IPCC) was unsound. Specifically, critical reviews of the science were not afforded adequate attention or were undermined outright as part of a broader conspiracy.

In addition to these objectives, the process that was followed by the IPCC in developing consensus assessments on the state of the science and the impacts of global warming was characterized as flawed. This process-oriented issue was pursued to a far greater extent in subsequent Committee activities and outside the scope of this report.⁷³

1. Are Faulty Models Being Promoted by the Science Community to Influence Policy?

"Skeptic" scientists have focused most of their criticism of global change science on the use of Global Circulation Models (GCMs) to project future temperature increases as greenhouse gas concentrations increase in the atmosphere. GCMs are the main tools that scientists have used to understand the behavior of the climate and its sensitivity to induced changes such as man-made greenhouse gas emissions. These models provide short-term weather predictions out to about a week and also provide a direct understanding of seasonal to inter-annual phenomena such as El Nino. For long term climate change, such models help interpret statistical deviations from a normal climate under various scenarios for greenhouse gas emissions.

The "skeptics'" criticism of GCMs and global warming takes two forms, although there are any number of specific examples. First, "skeptics" argue that it is more reliable to use observed data than a theoretical model to project future global warming. Since greenhouse gases have already increased about 50% over preindustrial levels and the global temperature rise to date is about 0.5 degrees C, then the amount of warming that should result from a doubling of CO₂ is only

⁷³ While these issues were not addressed in the hearing itself, the Majority inserted extensive materials in the published record relating to alleged procedural flaws in the IPCC process. See for example, Global Climate Change Hearing, *supra*, at pp 278-1056.

about 1 degree C.⁷⁴ This warming, in their view, is negligible for policy purposes. Models which predict higher levels of temperature increase should be disregarded because they are susceptible to manipulation.

Second, "skeptics" attempt to "test" the GCMs by comparing the "predictions" of the GCMs with observed data. If there are discrepancies between the GCM prediction and observed data, "skeptics" argue that they have proven that the GCMs are **wrong**.⁷⁵ This charge resonates with a corresponding tenet of the Republican Vision for science which states that "science programs must seek and be guided by empirically sound data."⁷⁶ That is, model data which do not clearly fit observations must, by definition, be unsound regardless of whatever insights models provide.

To be certain, a major goal of the modeling community is to replicate the past climate record and other observable characteristics. Models have been improved markedly over the past five years and describe the general characteristics of the climate reliably enough to support policy decisions. However, model limitations do exist and additional model improvements are needed. The arguments *du jour* advanced by the "skeptics," which seek to exploit these remaining uncertainties, are generally invalid because the purported comparisons set up a false test between incomparable data and specific model simulations, as discussed in more detail below.

a. Are global circulation models wrong because they fail to replicate historical temperature trends?

"Skeptics" argue that GCMs overestimate global warming. To support those claims, they point to the "failure" of GCMs to replicate historical temperature trends. If a model cannot accurately predict actual past temperatures, the argument goes, it certainly can't be reliable for predicting future temperature changes. Dr. Michaels argued, for example, that one set of models overestimates today's actual temperatures by about 1.2 degrees.⁷⁷ Dr. Michaels

⁷⁴ See, e.g., Jastrow, Robert; Nierenberg, William; and Seitz, Frederick, "Global Warming: What Does the Science Tell Us?" (Washington: George C. Marshall Institute; 1990) at 59-60. This projection assumes that (1) all of the global warming to date is from increases in atmospheric concentrations of greenhouse gases; (2) that temperature responds linearly to increasing atmospheric concentrations of greenhouse gases; and (3) there are no other human influences on climate that affect the warming trend. All three of these assumptions are highly questionable.

⁷⁵ This report examines the specific claims made during this hearing, but it should be noted that climate change "skeptics" present entirely different tests in other hearings and publications.

⁷⁶ Science Committee Vision Statement, "Strategies to Promote Scientific Integrity", 1996.

⁷⁷ Dr. Michaels testified, "...for the 1992 supplementary update, which was produced specifically to back the Rio treaty, a series of models were developed in which the CO₂ increased gradually. One percent per year was the forcing change in the model. That model becomes very testable against reality. And when you make the assumption that that model was producing the correct temperature when the greenhouse effect started to take off... and track the CO₂ increase in the (continued)

also suggested that GCMs were flawed because they fail to predict the fact that the observed temperature does not increase linearly with greenhouse gas emissions, citing the fact that balloon data shows no warming from 1965 through 1976 or from 1977 through 1994.⁷⁸ In addition, he noted that satellite data appear to show no warming trend over the last 17 years in contrast to the predictions of GCMs.⁷⁹

While reliance on "empirical" data seems at first glance to be an appealing reliance on "facts," there are two major difficulties with the characterizations presented by Dr. Michaels and other "skeptics." First, the empirical estimate must be sound and the comparison with models appropriate. Empirical estimates derived by other means provide good agreement with model results when this comparison is done properly.⁸⁰ Second, in reality both observational evidence *and* theoretical models are essential to constructing an *understanding* of what is being observed. Neither in isolation is sufficient nor superior from an intellectual standpoint, as suggested by the Republican vision statement. The scientific method, in its purest state, is based on observations, hypotheses, testing of hypotheses, and refining a theoretical construct to explain the phenomenon. An empirical extrapolation alone is subject to major uncertainties and misinterpretation not acknowledged by Michaels.⁸¹

Furthermore, Dr. Michaels' comparisons are unfair because he purports to test models against "predictions" the models never intended to make. For example, the model simulation which he criticized for its failure to replicate historical temperature trends was never intended to provide such a forecast, but instead was intended only to isolate and illustrate the impact of a particular idealized case of forcing. Modelers acknowledged at the time and at present that incorporation of aerosol effects, realistic emission scenarios, and other factors would be essential in order to generate an actual prediction.

model versus the northern hemisphere temperature, you get a difference of about 1.2 degrees between today's temperature and what was forecast." Global Climate Change Hearing, *supra*, at 51.

⁷⁸ Dr. Michaels testified, "We have measurements, accurate measurements of temperature in the atmosphere that are done by weather balloons twice a day. People really like these records because these are calibrated instruments. They go back into roughly the 1950s or so.... And if you look at the record, you see a warming in it.... Then if you look at the record carefully you see the following. There is no net change in temperature from 1977 through 1994, and there is no net change in temperature from when the record begins, Oort's [a scientist who has compiled balloonsonde data] record in 1965 to 1976. So that says that all the warming occurred statistically in one year. Now the question I have is, are we ever going to have a climate model that is going to be so good that it could pick something like that out." *Id.*, at 70.

⁷⁹ Dr. Michaels also charged, "Ladies and gentlemen, this is a large and propagating error that I believe should have been known to this Congress at the time of the 1992 Framework Convention, but it was not." *Id.*, at 26.

⁸⁰ See, for example, *Climate Change: The IPCC Assessment*, (Cambridge, UK: Cambridge University Press, 1990), sec. 3.5.1.

⁸¹ In response to post-hearing questions, Dr. Michaels further characterized his empirical estimate by saying, "One cannot be more substantive than the facts." *Id.*, at 1087.

The claim that the models fail to replicate precise non-linear changes in historical temperature records is a similar "straw man" argument.⁸² The intent of the model is to identify long-term changes. It is clear that climate variability, when viewed on short time scales, shows many sharp changes from one year to the next.⁸³ Model simulations actually show similar year-to-year fluctuations, but because of the natural chaotic variability of the climate, one cannot expect exact replication by any long-term simulation model that is not closely tied to the evolving weather. However, averaging over few-year time scales in the record - a more appropriate approach for comparing model results and observations - these sharp changes disappear and the long-term warming trend is clearer. As Dr. Watson responded in his post-hearing record submission:

"Both the simple climate models and General Circulation Models used by the IPCC are suitable for policy formulation. The fact that they do not simulate every bump and wiggle in the observational record is not surprising given that they do not attempt to simulate every natural phenomena that affects the Earth's climate on short time scales.... What is interesting is that the temperatures stayed elevated - unlike natural fluctuations, the average did not return to its pre-jump level, hinting that this is likely a human-induced warming."⁸⁴

Similarly, the alleged discrepancy between GCM "predictions" and satellite data showing no warming over the last 17 years is another inappropriate comparison which also fails to prove that the GCMs are wrong. Dr. Michaels' claim of comparing this "empirical" data with models is fatally flawed on numerous counts.⁸⁵ First, the satellite data used by Dr. Michaels were not adjusted for

⁸² It should also be noted that, with respect to the display of the empirical observations in this particular illustration, Dr. Michaels chose the year in the record that maximized his point. Selection of a different year would have resulted in a different conclusion. This analysis, therefore, was not robust.

⁸³ To be certain, understanding the sharp changes Michaels has described and the period of apparent stability from 1940 to 1970 (which occurred mainly in the Northern Hemisphere) should be goals of the climate research community. There are several possible physical explanations for this. This corresponds to the period in which man-made sulfate emissions may have begun to exhibit a cooling effect that counteracted the greenhouse gas related warming. Models do not yet accurately incorporate sulfate emissions.

There is also an emerging sense that such discontinuities may be related to important **pattern** changes (e.g., in atmospheric circulation and in ocean-atmosphere coupling) superimposed on more gradual warming trends. Thus, a full understanding and modeling of such changes will require a fuller development of coupled atmosphere-ocean models. While this is a preeminent scientific goal for the science community, it may not be a prerequisite for policy development

⁸⁴ Global Climate Change Hearing, *supra*, at 1118.

⁸⁵ Research results not presented at this hearing suggests additional reasons for the differences listed here. These include: first, that atmospheric and surface temperature records, in locations where both measurements are available, show differences based on such factors as land-ocean differences, meteorological conditions, season of the year; and, second, that natural climatic
(continued)

known external effects such as volcanic eruptions and El Nino episodes. (Subsequent hearings on this subject clarified that, when such corrections were made, a warming trend was in fact evident in the satellite record.⁸⁶) Second, the model runs Dr. Michaels used for comparison were not intended or claimed to be an actual representation of the historical record and also purposely excluded anthropogenic aerosol and various other forcings.⁸⁷ Finally, the shortness of the record being compared would substantially detract from any conclusion, either positive or negative.⁸⁸ The best comparison of satellite data, adjusted for external effects, with time-dependent global warming models incorporating aerosols shows that the satellite-based warming trend of 0.09 degrees per decade is consistent with the model prediction of 0.08-0.3 degrees per decade.⁸⁹ Thus Dr. Michaels' characterization, in effect, established a false "straw man" for the apparent purpose of presenting contradictions that do not exist or were not claimed.

b. Do models overestimate the likely amount of future warming?

Climate change "skeptics" generally acknowledge that increasing emissions of greenhouse gases will have *some* impact on the Earth's thermal balance. They contend, however, that this effect is so small as to have no policy significance. The argument is based in part on the assumption, noted previously, that future temperature increases can best be understood by simply projecting past "empirical" temperature increases linearly into the future.

variations such as volcanoes and El Nino events cause different amplitude and spatial character in the changes that are induced at the surface and in the atmosphere.

⁸⁶ The IPCC concludes that satellite data, when corrected for other known influences, do show a warming trend that is generally consistent with theoretical estimates of greenhouse gas induced warming. Much work needs to be done, however, to extract comparable information from satellites that are directly related to ground level temperature measurements. Unfortunately, the shorter satellite record may frustrate a definitive analysis. With the present level of understanding, however, satellite-based temperature measurements do not contradict global warming models.

⁸⁷ As Dr. Mahlman testified, "The nearly 20-year MSU temperature record contains a number of factors that were *purposefully* not considered in the GFDL climate model run that Michaels uses for comparison. Most importantly, the observed temperatures from 1976-1995 are affected by a number of complicating factors that include:... climate response to *previous* warming/cooling forcings; a cooling offset due to massive eruptions from El Chichon and Pinatubo volcanoes; and the still uncertain cooling offset due to aerosol effects." Global Climate Change Hearing, *supra*, at 1071.

⁸⁸ Dr. Watson testified, "There are three problems [with the analysis]: (i) a seventeen year record cannot be used to derive a long-term trend in the Earth's temperature because the temperature fluctuates too much on such a short time scale due to a variety of natural phenomena; (ii) the observations cannot be compared to a model that does not include all natural and anthropogenic phenomena that affect temperature; and (iii) trends in surface temperature may be different than trends in mid-troposphere temperature." *Id.*, at 1116.

⁸⁹ IPCC Working Group I contribution to Second Assessment Report, section 8.5.5.

In addition, however, "skeptics" also point to the fact that recent improvements in the GCMs have also brought down estimates of the projected future temperature increase, implying that, as models get better, the estimates of global warming will continue to decrease and may reach a negligible value for policy purposes.⁹⁰ As Chairman Rohrbacher asked, "Is there a consensus that as we get better information because of better technology that is available to us, is this the consensus that actually that the degree of global warming has come down?"

The major change in the GCMs in the last few years is the development of a model which incorporates the "cooling" effect of aerosol sulfates, which are also produced by fossil fuel combustion. The model, developed by Mitchell, *et al.*, drastically reduces the need for arbitrary model calibration adjustments (called flux adjustments) and produces a substantially better fit to historical temperature data on a global scale.⁹¹ With the offsetting effect of aerosol sulfates included, the Mitchell model suggests a slower rate of warming,⁹² but still projects a warming of 2.5 degrees C for a doubling of CO₂, which is near the middle of the range of model estimates.⁹³

While Dr. Michaels cites such studies as a validation of the "skeptics" criticisms that earlier models overestimated global warming, the Mitchell model uses a completely different analysis than that used by the climate change "skeptics." As noted previously, most "skeptics" predicted future global warming by simply extrapolating past temperature increases into the future. The Mitchell model, in contrast, relies on complex interactions of the climate system. More importantly, it is not correct that the Mitchell model has confirmed the "skeptics" charges that global warming was overestimated by prior models. Indeed, the Mitchell model's projections of warming due to increased carbon dioxide remains consistent with earlier models. The difference is simply that the Mitchell model now *subtracts* from the expected greenhouse warming the cooling effect of sulfate aerosols. As Dr. Mahlman indicated:

"Michaels' statement appears to be factually incorrect for two important reasons. First, Dr. John Mitchell's calculations indicate that the measured global warming to date is generally consistent with a climate model of 2.5 degrees C warming response to

⁹⁰ Dr. Michaels testified, "The early suite of models produced an average warming of about 4 degrees Celsius for doubling carbon dioxide, and the data suggested a much lower number, about 1 to 1.5 degrees of additional warming. The most important development in the last two years is that it is now acknowledged that the community that argued for the lower numbers appears more likely to be correct." Global Climate Change Hearing, *supra*, at 25.

⁹¹ JFB Mitchell, *et al.*, *Journal of Climate*, Vol. 8, p. 2364; JFB Mitchell, *et al.*, *Nature*, **376**, 1995, p. 501.

⁹² The model results suggest that the warming trend with aerosols is 0.2 degrees K per decade vs. 0.3 degrees K per decade for greenhouse gases only.

⁹³ The range 1.5 to 4.5 degrees C results mainly because of uncertainties in each model in how the amounts and character of clouds will change. This range describes the amount of warming that would occur from an idealized equilibrium simulation in which CO₂ is doubled.

doubled CO₂, when the best *guess* value for the current sulfate offset is included. Second, such a result, in itself, has *nothing* to do with a changed sensitivity to doubled CO₂ in his model.... The sulfate offset of greenhouse-gas induced warming is the reason for the lowered IPCC warming projections."⁹⁴

For policy purposes, the difference could be crucial. Carbon dioxide could stay in the atmosphere for as long as 500 years, while sulfate aerosols have a much shorter atmospheric lifetime - in the range of a week for most anthropogenic sources.⁹⁵ If the "cooling effect" of constant sulfate aerosol emissions ends long before the "warming effect" of CO₂, the greenhouse effect could appear to escalate sharply. In a sense, sulfate aerosols may only mask present global warming, and delay its unambiguous appearance until later - when policy measures may be too late to be effective.

c. Do models fail to account for aerosol effects?

One of the most significant recent model developments which has improved the comparison of model results with actual temperatures is the inclusion of aerosol effects. However, Dr. Michaels challenged this consensus view. He articulated his challenge in a visual demonstration (using an inflated globe) in which he pointed out that models which *do not* incorporate aerosols *also* fail in the Southern Hemisphere where aerosols are at a minimum. In effect, he claimed to test the assertion of the scientific consensus that inclusion of aerosols improved the fidelity of the models and should give added weight to their use for policy purposes. He summarized this point by saying:

"The point that I am trying to make to you, aerosols may have some effect. I believe they do, particularly in the northern hemisphere, but they are not a sufficient cause to explain the difference between the projected and the observed warming...."⁹⁶

It is important to note that this argument was based on an implicit assumption - which Dr. Michaels treated as obvious - that the climatic effects of aerosols should be seen in the same areas that aerosols are emitted. This seemingly intuitive linkage may not reflect the actual complexity of the atmosphere. A large volume of scientific work, not acknowledged by Michaels, has suggested that the climate system is sufficiently complex that the regions for forcing climate changes

⁹⁴ Response to post-hearing questions, Global Climate Change Hearing, *supra*, at 1073.

⁹⁵ *Id.*, at 64.

⁹⁶ *Id.*, at 65.

and areas in which the climate responds can be, and in fact are, different.⁹⁷ This is an area of ongoing investigation by many modelers.

In general, models perform well in describing large-scale features but do not claim to be reliable for describing regional-scale changes. Thus it is a foregone result that a comparison of regional data with regional model output will suggest unsatisfactory model performance. This criticism is again an example of a "straw man" argument, creating and then disproving a claim which the models do not make.

2. Have Scientists Misled Policymakers on Climate Change Science?

A common theme in the "skeptic" literature is that climate change scientists, eager to retain Federal funding, have knowingly misled Congress and the international policy community by failing to disclose the weaknesses in the models and suppressing dissenting views. Again, the hearing failed to substantiate any of these claims.

a. Did scientists mislead Congress on the limitations of GCMs?

Dr. Michaels charged that scientists failed to disclose to Congress and the international community that there were significant discrepancies between the observed global temperature trends and predictions of the GCMs.⁹⁸ In referring to the fact that satellite data showed no warming trend, he charged: "Ladies and gentleman, this is a large and propagating error that I believe should have been known to this Congress at the time of the 1992 Framework Convention, but it was not."⁹⁹ In a similar vein, he charged that, "In 1992, when the Rio Treaty was signed, and the climate models did not have sulfate aerosol in them, I believed

⁹⁷ See, for example, Taylor and Penner, *Nature*, **369**, 1994, pp. 734-737. In addition, Dr. Richard Lindzen, another noted "skeptic," explains the very strong climatic change evidenced by the occurrence of past glacial cycling by postulating a very strong global climate sensitivity to orbitally-induced regional and seasonal patterns of change in solar radiation comparable in size to aerosol-induced changes. The view that regional changes can induce widespread global effects is directly contrary to the Michaels view articulated in the hearing. The IPCC position reflects a middle ground.

⁹⁸ For example, Dr. Michaels stated in his opening statement, "...it is apparent that the climate model that was most heavily cited by the United Nations in a special supplementary report on climate change... was known to be making large errors in the forecast of current temperature at the time of the adoption of the framework convention. And yet this never entered into the debate surrounding that issue. These observations strongly suggest that the scientific review process that bases these international agreements has been highly flawed, or there may simply have been omissions in communicating to responsible individuals how large the errors in these calculations were." Global Climate Change Hearing, *supra*, at 25.

⁹⁹ See Note 79, *supra*.

that people who testified in front of Congress knew that the error was as large as it was.... Why was that not told to this Congress?"¹⁰⁰

However, when asked in post-hearing questions to identify specific testimony or instances where scientists allegedly misled Congress, Dr. Michaels could not identify any such instances, and responded only that the scientists testifying before Congress should have known about the discrepancies. He stated, "There must have been some opportunity during 1990-1992 for people responsible for that model to testify in front of either a House or Senate Committee!"¹⁰¹

Dr. Michaels' allegation of a conspiracy to mislead Congress hinges on the assumption that the "discrepancies" between the GCM "predictions" and observed data meant that the GCMs were fatally flawed. As noted above, such "straw man" comparisons are in fact not a scientifically appropriate test of the validity of GCMs. Further, Dr. Michaels could not substantiate his claim that scientists had misled Congress and the international community about the limitations of GCMs. In fact, his testimony was contradicted by Dr. Watson, whose post-hearing submission provided an extensive selection of relevant text from the 1992 IPCC assessment which clearly acknowledged from the outset that known uncertainties in model results existed and there was a need to include aerosols and other model improvements in future assessments. For example, from Dr. Watson's response, quoting from the 1992 IPCC assessment:

- "the evidence from the modeling studies, from observations and the sensitivity analyses indicate that the sensitivity of global mean temperature to doubling CO₂ is unlikely to lie outside the range of 1.5 to 4.5 C.;"
- "....there are many uncertainties in our predictions particularly with regard to timing, magnitude and regional patterns of climate change.;" and
- "The cooling effect of aerosols resulting from sulfur emissions may have offset a significant part of the greenhouse warming in the Northern Hemisphere during the past several decades. Although this phenomenon was recognized in 1990, some progress has been made in quantifying its effect."¹⁰²

¹⁰⁰ Global Climate Change Hearing, *supra*, at 51.

¹⁰¹ Dr. Michaels testified before the Environment Subcommittee of the Committee on Science in May, 1992, and informed Congress of the large alleged discrepancies between the predictions of the GCMs and observed data. Michaels testified both to the discrepancies with the satellite data and the failure of GCMs to reproduce historical temperature trends, concluding that GCM projections of warming were seriously overestimated. See *The U.S. Global Change Research Program*, Hearings before the Subcommittee on Environment of the House Committee on Science, 102nd Cong., 1st Sess., No. 148 (May 5, 1992).

¹⁰² Global Climate Change Hearing, *supra*, at 1121 *et seq.*

It is evident that the IPCC explicitly recognized from the outset that aerosols and other effects were much needed and desirable improvements to be included in scenarios of human activities and treated in models.¹⁰³ Dr. Michaels' claim that the limitations of GCMs were deliberately understated is not substantiated by the IPCC documents themselves.

b. Did scientists exaggerate the likelihood or impacts of global warming to serve their own interests?

During the course of the hearing, several witnesses inferred that scientific results were affected by sponsorship, funding sources, and other self serving motives.¹⁰⁴ Dr. Michaels said, "...testimony has repeatedly been given in front of this Congress that the modeled and observed temperatures were broadly consistent. This view has been amply rewarded."¹⁰⁵ Dr. Moore echoed this theme, saying, "I cannot help mentioning that Steve Schneider [a climate change scientist at the National Center for Atmospheric Research] was a great advocate of global cooling as a problem in the 1970s and since that did not sell he now sells global warming."¹⁰⁶

The general theme that the integrity of Federal research is undermined by a political viewpoint dictated from the White House is a strong theme of the critics of global climate change science. It also incorporates an assumption that the science community possesses a self interest identical to any other interest group and scientific results can be manipulated to optimize that self interest. However widespread this viewpoint, the hearings failed to establish any evidence that such political manipulation of science has in fact taken place.

In reality, different Administrations do, in fact, affect the overall thrust areas of research in the normal course of steering Federal policy. For example, the Reagan and Bush Administrations initiated the global change research program and focused strongly on questions pertaining to whether human-induced climate change was a real issue. The present Administration has maintained this initial focus but expanded it to include potential impacts and consequences. This later expansion was in response to widespread criticism that such research was essential to develop rational policies.

¹⁰³ Similarly, the most recent IPCC assessment contains an extensive discussion of the limitations of GCMs and present knowledge. See, e.g., IPCC WGI, *Climate Change 1995: The Science of Climate Change* (Cambridge, U.K.: Cambridge University Press, 1995), pp. 229-285.

¹⁰⁴ Dr. Michaels and others have been more forceful in their published writings criticized Federally-funded scientists as "shilling for the apocalypse." See Michaels, Patrick, "Free Markets, Free Science," *Washington Times*, December 15, 1992 (p. F2).

¹⁰⁵ Global Climate Change Hearing, *supra*, at 25.

¹⁰⁶ *Id.*, at 237.

Beyond this, however, the individual scientists carrying out the research have remained largely the same in the world scientific community, the U.S. academic community, and, for the most part, in the Federal Government. In addition, the nature of their research has remained largely the same. There is no evidence that any widespread shift in the tone and direction of their research took place as a result of the 1992 elections.

One significant issue that was not discussed in this hearing relates not to the conflict of interest charges against Federally-funded scientists, but to the potential conflicts of interest for the "skeptics" themselves. In this case, Dr. Michaels emphasized his academic credentials for the purposes of the testimony. Yet, one major vehicle used for publicizing the arguments and analyses of climate change "skeptics" has been the *World Climate Report* funded by the Western Fuels Association.¹⁰⁷ Although this linkage alone does not in any way invalidate the arguments that climate change "skeptics" have raised, the Members had no knowledge of such funding sources during the hearing. Conceivably, such knowledge for all of the witnesses could have affected the perceptions gained by the Members of the credibility of the witnesses and could have provided a balance for the discussion relating to the motives of Federally-funded scientists.

c. Have scientists ignored or suppressed dissenting views or information?

A key complaint made by Dr. Michaels during the hearing relates to the purported limited availability of data generated in support of the IPCC assessment. He stated that he had been denied underlying data needed to evaluate a new model which the IPCC was relying upon for key projections of global warming.¹⁰⁸ Essentially, he contended that the model response of the Arctic region to increasing greenhouse gas and sulfate emissions provided a critical test of the validity of the model. Without the actual grid point data, Dr. Michaels argued, he was unable to provide critical review for the IPCC assessment.¹⁰⁹

¹⁰⁷ *Id.*, at 1110. The Western Fuels Association describes the *World Climate Report*, a biweekly newsletter, as intended to "provide a rapid response to the spurious reports that try to create virtual climate reality, a phony picture of increasing weather catastrophes caused by CO₂ emissions."

¹⁰⁸ "...I requested from the United Nations that they send me the data that went into that model, and I was denied. I wrote back and I said this is a horrible breach of scientific ethic. You must send me the data because I have been asked by the United Nations to review their own work. I was denied.... Therefore, any policy statements or any impact statements that are made on these new, more reliable models are based on models that were not subject to review by those who were known to provide critical review in the process." *Id.*, at 27.

¹⁰⁹ The Grid Point Data is the detailed, and voluminous, numerical output of the model. The data actually provided to the IPCC and normally exchanged by scientists is the refined version of this data which is interpretable in a physical way.

Notwithstanding whether the request was reasonable by conventional standards or whether there was any real possibility that the analysis would have impacted the assessment, Dr. Michaels' argument raises a legitimate issue that posits the traditional rights of scientific investigators against the need for early and open access to research used in an international assessment.

From a science culture standpoint, tradition generally recognizes that originators of data must have sufficient time to explore their own data before releasing it; especially, as was the case here, when the actual data are more extensive and detailed than that incorporated in the public paper.¹¹⁰ There is also a widely recognized standard that information gained in the peer review process should not be disclosed by the reviewer.

At the same time, the issue of sharing of environmental data is evolving rapidly in view of the perceived importance of global effects of global warming and ozone depletion. The international scientific assessment process is still a new and evolving process and such conflicts should not be unexpected. The issue is further complicated by a variety of cultural and legal differences in the views of various countries toward scientific data.

While the issue of access to data merits further discussion, Dr. Michaels' contention that there was a **legal** obligation for the United Kingdom Meteorological Office (UKMO), under whose auspices the model data were developed, to provide the data to him, is problematical. Dr. Michaels argued that, since the IPCC was presenting some results from the UKMO model, and U.S. taxpayer dollars in part supported the IPCC process, all such data should be treated as publicly available to U.S. researchers. Although a full review of this issue has not been carried out, it is not obvious that U.S. support for the *administrative* costs of the IPCC assessment process constitutes an adequate basis to assert public data rights with regard to research conducted by non-U.S. participants. U.S. Federal agencies, as well as other countries, have established data policies designed to ensure broad dissemination of knowledge while protecting the intellectual property rights of principal investigators. The proprietary nature of data generated by the U.K. model may be a fully valid concern.¹¹¹

From a purely scientific standpoint, Dr. Michaels' request for UKMO data may be appropriate and access to such data could conceivably contribute to the review process. However, there is no evidence that the denial of such data was inconsistent with U.S. law or was part of an overall conspiracy to suppress dissenting views.

¹¹⁰ Subsequent to the Michaels request, the UKMO actually released this data to others collaborating in the research and the data are now intended to be available upon request.

¹¹¹ Dr. Mitchell states that "the data does not belong to the IPCC, it belongs to Her Majesty's Government". Global Climate Change Hearing, *supra*, at 1190.

d. Have scientists ignored the benefits of global warming?

Critics of global climate change science have alleged that mainstream scientific efforts to quantify the impact of possible global warming invariably address only possible negative impacts of global warming, and consistently ignore potential benefits. Dr. Watson, who co-chaired the IPCC Working Group II on Impacts of Global Warming, testified on the efforts of that group to quantify impacts. The report, which was being finalized by the IPCC at the time of the Subcommittee's hearing, contained projections on the impacts of the mid-range global warming estimate on terrestrial and aquatic ecosystems, hydrology and water resources management, food and fiber, human infrastructure, and human health. The Subcommittee chair and others were critical of such "dire predictions" and called them "misleading."¹¹²

In fact, the IPCC impact assessment does include consideration of benefits. The "Summary for Policymakers" prepared by the IPCC Working Group chaired by Dr. Watson, for example, discusses potential regional benefits of global warming for agriculture. The Summary notes that warmer temperatures and the fertilization effects of higher CO₂ levels would lead to increases in agricultural productivity in some areas, but that such increases would be offset in other areas. Overall, the Summary projects that current levels of agricultural production could probably be maintained.¹¹³ However, as the report also makes clear, all of the projections for regional changes are highly uncertain because of the very limited ability of models to assess changes from global warming at the regional scale.

Dr. Thomas Gale Moore testified on the general social and economic benefits realized in past societies by naturally-occurring warming episodes. While Dr. Moore's testimony was suggestive of ways that society could benefit from warmer temperatures, his testimony with respect to paleoclimatology and regional impacts of CO₂-induced climate change would certainly appear to go beyond his area of academic expertise in the economics of transportation regulation and appears to be at odds with the views of scientists with expertise in those areas.¹¹⁴

¹¹² *Id.*, at 76.

¹¹³ IPCC WGII, *Climate Change 1995: Impacts, Adaptations and Mitigation, Summary for Policymakers* (New York: Cambridge University Press, 1995), p. 10

¹¹⁴ See statement of Dr. Thomas Gale Moore submitted for the record; Global Climate Change Hearing, *supra*, at 147. As noted in the questions submitted for the record by Rep. George E. Brown, Jr., paleoclimatologists whose work Dr. Moore relied upon now question whether there was a global "Medieval Warm Period," casting doubt on Dr. Moore's effort to correlate social and economic development with past warming events. *Id.*, at 1147. Moreover, some paleoclimatologists question the utility of comparing past naturally-occurring warming episodes with CO₂-forced climate change, which is likely to force temperature increases well beyond those realized in recorded human history. Such warmings may radically change precipitation patterns
(continued)

3. Science and Policy: Are Global Warming Models Adequate for Policymaking?

a. "Uncertainty" vs. "Reliability"

As noted above, "skeptic" scientists have attacked GCMs as fatally flawed for their failure to replicate certain observed data. While the comparisons they make are not scientifically appropriate, the criticisms do raise a legitimate policy issue about reliance on models for predictions of the future which cannot, by their very nature, be verified until the future actually happens.

The arguments against models made by critics of global climate change science fundamentally confuse different concepts. Throughout the hearing, witnesses and Members utilized the terms "reliability", "uncertainty", and "accuracy" to describe the ability of models to characterize future global warming. In introducing the hearing topic the Chair stated that the Subcommittee would examine the "controversy over the reliability" of the computer models for climate change. Dr. Michaels, in characterizing older models which did not incorporate aerosols with newer models which do, uses the term "error" to describe model differences.

Clearly, a model known to be *unreliable* or *erroneous* would not likely be considered adequate to support policy decisions. A model known to be *uncertain* could well support policy decisions depending on the range of uncertainty and the consequences of erring either passively or actively. In this case, GCM models are believed to be accurate on a global scale but not definitive (i.e. uncertain) on regional scales. While "skeptics" focus on the potential of models to overestimate global warming, the models are in fact equally likely to *underestimate* global warming. As Dr. Mahlman noted, "...[W]hen you have made your best estimate of the way things are, it automatically says that you do not know whether you are wrong on the high side or the low side."¹¹⁵ Mr. Guerrero amplified this view, saying, "...that degree of uncertainty is expressed in the range. When scientists talk about a global surface temperature range by the year 2050 of one to 3.5 degrees Fahrenheit, embodied in that range is the sense that... it could be on the low side or on the high side."¹¹⁶

from those that occurred in past natural warming episodes, with obvious regional impacts on social and economic development. Crowley and North, *Climatology* (London: Oxford University Press; 1991), p. 89. In addition, it is questionable whether it is possible to quantify measures of "progress" for the purposes of correlating progress with past warming periods. For example, Rep. Rivers noted that other periods associated with "progress," such as the Roman Empire, the Renaissance, and the Industrial Revolution, all occurred in colder times. Global Climate Change Hearing, *supra*, at 241.

¹¹⁵ *Id.*, at 63.

¹¹⁶ *Ibid.*

Thus, it is clear that the science community has attempted to provide a measure of certainty associated with such assessments. This is, however, fundamentally a policy tool rather than a scientific imperative. The duty of the policymaker will be to ensure that a prudent policy accounts for consequences more severe, as well as less severe, than the central estimate.

b. "Predictions" vs. "Projections".

In another key line of questioning, Chairman Rohrabacher contrasted the use of the word "projection" used by the IPCC with the word "prediction" more popularly used in the media. Specifically he defined projections as being based on unvalidated assumptions, implying that these would thus be unsuitable for policy decisions. He said:

"...I've been reading all kinds of predictions... that say... our coast lines are going to be inundated, that people are going to be dying of malaria. I mean these were dire predictions. After this testimony today, I am not leaving this hearing feeling that those predictions were justified."¹¹⁷

In commenting on this issue, Dr. Mahlman submitted the following statement:

"I do agree with Chairman Rohrabacher that the greenhouse gas projections are based on unvalidated assumptions about the future. They are based on unvalidated assumptions about, for example, population growth, policy decisions about fossil fuel use, maintenance of CFC phaseout protocols, and coal use in developing countries."¹¹⁸

By their very nature, assumptions about the future cannot be validated. As the Chairman noted, assumptions about the future can turn out to be wrong.¹¹⁹ The *policy* question is whether it is better to try to make policy based on our best efforts to understand probable future trends, or simply to abdicate to random chance. Certainly, the widespread use of economic models for many policy purposes, despite their obvious limitations, suggests a consensus that efforts to understand the future effects of our actions are worthwhile. The fact that models must use unvalidated assumptions does not mean that models are an inherently **unreliable** policy tools, as implied by climate change critics.

In choosing terms to describe the ability of models to project the impact of increasing CO₂ emissions, it must be acknowledged that the true answer is yet

¹¹⁷ *Id.*, at 76.

¹¹⁸ *Id.*, at 1075.

¹¹⁹ *Id.*, at 75

unknown. However, without a completely analogous geophysical case to test the model, the "accuracy" of a model with respect to this projection cannot be defined unambiguously. In addition, as yet, fully comprehensive comparisons of model results with the historical temperature record cannot be made. Thus model "reliability" cannot be fully defined. The most appropriate way to describe the current state of models is to indicate the test cases that models have simulated and, in so doing, to indicate their ability to meet these tests and the resulting shortcomings and qualifications to consider in evaluating model results.¹²⁰ The current concept of uncertainty is intended to provide reasonable brackets around the range of results that encompass these shortcomings and qualifications.

This is a valid concept to support policymaking as long as policymakers are cognizant of the sources of uncertainty, range of uncertainty, and consequences of making wrong decisions. In addition, the "uncertainty" in a model provides a rational basis for carrying out research to improve the models for policy purposes. Within their capabilities, GCM models can be useful as policy making tools, depending on value-based considerations concerning their findings.

4. Is There a Scientific Basis for the Claim that Humans are Responsible for Global Warming?

The timing of this hearing was significant in that it took place immediately following the release by the IPCC of a scientific assessment stating for the first time that human activities have caused a discernible increase in global temperature over the past several decades. This finding is significant inasmuch as the natural variability of the Earth's climate, together with incomplete data on temperature measurements had, up to that time, frustrated attempts to extract a clear indication of human-induced climate change from the record.

This state of affairs was characterized by Dr. Mahlman as follows:

"Global surface warming over the past century [is] virtually certain. The observed warming in the surface temperature records of about one degree Fahrenheit cannot yet be unambiguously ascribed to greenhouse warming. However, no other hypothesis is nearly as credible."¹²¹

¹²⁰ Some of the tests that the science community rely on to assess the performance of models include: field and laboratory studies which allow the testing of short term chemical, physical and biogeochemical processes; day-to-day weather forecasting out to several days in advance; seasonal to inter-annual simulations out to one year in advance; biogeochemical cycles and atmospheric chemistry which are thought to be several years in cycle duration; and, paleoclimate studies which address century time scale processes comparable to the global warming phenomenon.

¹²¹ Global Climate Change Hearing, *supra*, at 19.

Thus, according to this view, there is no unequivocal "smoking gun" in the traditional sense for the gross aspects of the historical temperature record. Nonetheless, given the fact that there are no other credible hypotheses to explain the temperature increase over the past century, the consensus of the scientific community has settled on global warming as the likely cause.

Subsequent to these hearings, the IPCC finalized in the closing months of 1995 the conclusions of the fifth session of Working Group I dealing with the state of scientific consensus on global warming. Significantly, this assessment concluded that "the balance of evidence suggests a discernible human influence on global climate." This conclusion was based on pattern-based work in which the "fingerprint" for human-induced effects was recognized. That is, some features of a human-induced pattern of global change, such as stratospheric cooling, Northern vs. Southern Hemisphere differences, and other large-scale regional phenomena have been recognized to emerge with statistical significance over time. The striking similarity of modeled vs. observed patterns was deemed by the international scientific community to warrant a more conclusive finding than has been the case in past assessments.

It is also of significance that this more affirmative finding has been subject to a particularly focused attack by "skeptics," not on substantive scientific grounds, but on procedural grounds. Specifically, the editorial process by which this new finding was developed has been criticized by the "skeptics" and the fossil fuel industry as flawed and failing to adequately incorporate contradictory statements. Although hearings on this issue have not yet been held by the Committee, a preliminary review of the documents in question fails to demonstrate anything other than customary editorial practice.

C. THE DIOXIN REASSESSMENT HEARING

The third hearing in the Scientific Integrity series was held on December 13, 1995. This hearing focused on the Environmental Protection Agency's (EPA) Dioxin Reassessment process. Two interrelated allegations of scientific misconduct were the focus of this third case study. The first charged that the final chapter was composed without utilizing a peer review process to guarantee the scientific quality of the important summary chapter of the reassessment. Second, critics alleged that the final chapter was heavily slanted to exaggerate the risks of dioxin. In sum, the critics claimed that EPA had misused science to lay the groundwork for an unjustified regulatory assault on dioxin.

In his opening statement Chairman Rohrabacher clearly stated the allegations which were the focus of the hearing:

"There is no question good science was produced in the EPA's document. The EPA issued an open call to the best scientists in

the field to participate and many of them did. In many respects, the early stages of this process were a model of peer review and sound science and the EPA is to be commended for it. When it came time to write the critical portion of the Health Effects document, however, it appears the doors were closed and the EPA drew its own conclusions."¹²²

To make the case for EPA's systematic exaggeration of dioxin risks and abandonment of the peer review process, the Majority relied upon the testimony of two witnesses, Dr. Michael Gough and Dr. Kay Jones. Although the report of the EPA's Science Advisory Board (SAB) and its peer review of the EPA assessment was a central focus of the hearing, the hearings included no witness to represent the Board.

The hearing resulted in no credible substantiation of any of the charges made by the Majority. As the analysis presented in the following sections will demonstrate, the dioxin reassessment process has been open and transparent. It afforded the public, affected industries, and scientists representing divergent views ample opportunities to participate in the development of the dioxin reassessment. Two of the authors of the dioxin reassessment, Dr. William Farland of the EPA and Dr. George Lucier of the National Institute of Environmental Health Sciences (NIEHS) testified at this hearing. They admitted to choosing options that were most protective of public health and the environment when presented with choices about how to fill in knowledge gaps about the biology of dioxin to estimate risk. However, no evidence was presented to substantiate the claim that these assumptions or interpretations were, in fact, not scientifically defensible.

EPA's Dioxin Reassessment

EPA completed two earlier risk assessments for dioxin in 1985 and 1988. The current reassessment of dioxin was initiated in 1991 by the Bush Administration.¹²³ In 1988, the SAB reviewed a draft exposure document and a draft health assessment document related to the determination of carcinogenicity of dioxin. At the time, the SAB recommended that EPA "follow up on this excellent start" by developing new methods to estimate human exposure to

¹²² Opening statement of Chairman Dana Rohrabacher; *Scientific Integrity and Federal Policies and Mandates: Case Study 3 - EPA's Dioxin Risk Reassessment*, Hearing before the Subcommittee on Energy and Environment of the House Committee on Science, 104th Cong., 1st Sess., No. 39 (December 13, 1995), p. 5. (Hereinafter cited as "Dioxin Reassessment Hearing.")

¹²³ The Congressional Research Service report: "Dioxin: Reassessing the Risk," provides a summary of the history of the reassessment and the current issues associated with it. CRS 95-1059, Oct. 25, 1995.

dioxin and to estimate the dose-response relationship for this chemical.¹²⁴ Reports of a study funded by the paper industry and of a conference sponsored by the chlorine industry also played a role in initiating the reassessment. The paper industry's request that EPA reconsider the assumption of "no safe level of dioxin" as the basis for setting regulatory standards may also have contributed to the Agency's decision to initiate the reassessment.¹²⁵ The reassessment is not expected to be completed until sometime next year.

1. Did EPA Abandon the Use of the Peer Review Process in Developing the Dioxin Risk Characterization?

Chairman Rohrabacher's comment to the effect that EPA had closed the doors and drew its own conclusions when they composed the risk characterization portion of the health effects assessment echoed criticisms of EPA made in the press and by some in the scientific community. Critics charged that EPA had written the risk characterization chapter (Chapter 9) without input from outside scientists and had submitted that chapter to the Science Advisory Board for review rather than bringing together a panel of outside experts for review as they had with each of the other chapters. Implicit in the Chairman's comment was a charge that EPA had deliberately evaded peer review on Chapter 9.

The charge, however, is incorrect. While EPA's process of drafting the risk characterization chapter was different for the reasons discussed below, it was always EPA's intention to have the Science Advisory Board conduct the peer review of the entire report, including the risk characterization chapter.

The first eight chapters of the dioxin health reassessment summarized the state of scientific knowledge on different aspects of dioxin. Each of these chapters was drafted by a team of authors which consisted of between 2 and 14 authors; at least one of whom was an EPA scientist. In the case of chapters 6 and 7, the outside author was also a government scientist, but not from EPA. Of the thirty authors who worked on Chapters 1-8, sixteen were scientists from outside the government. The majority of the government scientists who authored these chapters were from the EPA, two scientists were from different institutes of the

¹²⁴ Environmental Protection Agency (EPA) Science Advisory Board, "Resolution on the Use of Mathematical Models by EPA for Regulatory Assessment and Decision-Making," EPA-SAB-EC-90-003, 1989.

¹²⁵ Bailey, Jeff, "Dueling Studies: How Two Industries Created a Fresh Spin on the Dioxin Debate," *Wall Street Journal*, February 20, 1992, p. A1. The article states: "...[P]aper company executives called on Mr. Reilly in January 1991 with their version of the Banbury meeting. 'Despite the emergence of a consensus in the international health community that the risks of dioxin have been seriously overestimated,... none of these developments has received positive acknowledgment by Agency staff,'" they said in a letter to Mr. Reilly recapping the meeting. They asked again for a reassessment of the EPA's strict dioxin regulations - and suggested "accelerated efforts."

National Institutes of Health. EPA also convened an outside panel of thirteen scientists to review those eight chapters. Chapter 7 received additional review by a second panel of eight scientists. Of the twenty reviewers selected, two were government scientists. Neither were from the EPA.

The procedure followed for drafting and reviewing the risk characterization chapter (Chapter 9) of the reassessment differed from that of the other eight chapters of the document. The risk characterization chapter¹²⁶ was prepared by Dr. William Farland of EPA, and was not reviewed by a panel of government and non-governmental scientists as the previous eight chapters were. However, Chapter 9 was reviewed by an interagency panel of scientists which included representatives from five Departments and three sections of the Executive Office of the President prior to its review by the SAB.¹²⁷

Following this review, Chapter 9 was made public in September, 1994, and EPA solicited public comments on the report for 120 days.¹²⁸ In addition, the agency held eight public meetings in December 1994 to receive oral comments on the document. A summary of the risk characterization conclusions were also presented by Agency staff at scientific conferences early in 1995, including meetings of the Society of Toxicologists and the American Association of Cancer Research. The entire report, including Chapter 9, was submitted to the EPA SAB for review in December, 1994. The SAB held a public meeting to receive additional comments and draft their findings in May, 1995.

Clearly, the risk characterization document was not a closely kept secret from the public or the scientific community prior to its submission to the SAB in December 1994. In sum, the risk characterization chapter underwent extensive scientific review inside EPA and by the SAB.

EPA created a different drafting and review process for the risk characterization chapter because the chapter had a different purpose than the first eight chapters, which summarized scientific knowledge on hazard identification, dose-response factors, and exposure information. The task of a risk characterization is to integrate all of the preceding information to provide an estimate of the risk to humans from actual exposure to the chemical, and a discussion of uncertainties and assumptions. As has been noted by the National Academy of Sciences, risk

¹²⁶ Chapter 9, "Risk Characterization of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds," U.S. EPA, Office of Research and Development, Washington, DC. EPA/600/BP-92/001c, August 1994, External Review Draft.

¹²⁷ The five departments were: the Department of Agriculture, the Department of Defense, the Department of Health and Human Services, the Department of Labor, and the Department of Veterans Affairs. The sections of the EOP included the Office of Science and Technology Policy, the Council of Economic Advisors, and the Domestic Policy Council.

¹²⁸ The process of developing and releasing the risk characterization chapter was laid out by Dr. Farland for the Science Advisory Board at the May meeting. His full description of the process is included in the transcript of the May 1995 meeting.

characterization often involves the use of scientific assumptions in the face of scientific uncertainty.¹²⁹ The choice of such assumptions is guided in part by policy considerations and therefore are appropriately made by the agency, not by outside scientists. In addition, while risk characterizations do not make risk management recommendations, the risk characterization is written in the context of policy decisions to be made by the risk managers, a task also appropriately left to the agency.

Critics seem to have equated the fact that the review process was different for the risk characterization chapter with a conclusion that the process was inadequate. Similarly, the Chairman apparently did not believe review by the SAB constituted an outside scientific review. Following Dr. Farland's explanation of the review process, Chairman Rohrabacher asked: "...but your contention is that this is your strategy all along... not to have the outside peer review for the final conclusions?"¹³⁰ Dr. Farland reiterated that the SAB review was the outside peer review. He further explained that one of the reasons for asking the SAB to review the risk characterization document was because of the independent nature of the Board. "...[O]ne of the issues I think is important here, Mr. Chairman, is that when we [EPA] do these peer panels, we actually decide who the peer reviewers are going to be, and the SAB process is an independent process."¹³¹

In the case of a review done by the SAB, EPA does not select the reviewers. The reviewers are selected by the SAB. It is ironic, that in an attempt to subject their risk characterization to a more independent process for review, the Agency was accused of attempting to avoid the peer review process.

The result of the peer review by the SAB has not been a simple rubber-stamping of the Agency's efforts, a result that would have been expected if the review process had failed or been a whitewash. Plans for revision of the document were underway at the time of the hearing. The revision of the draft is now proceeding with input from scientists both inside and outside the government, and it will be resubmitted to the SAB for a second review when the revision is complete. Contrary to the picture the Majority tried to paint, the dioxin reassessment process has been an extraordinarily open and transparent one and has included scientists with a variety of expertise and opinion. The hearing record provides no evidence that the EPA attempted to avoid outside criticism and review of its work

¹²⁹ In its 1983 report, the National Research Council discussed the use of "inference guidelines," which it defined as "an explicit statement of a predetermined choice among alternative methods (inference options) that might be used to infer human risk from data that are not fully adequate or are not drawn directly from human experience." An example of such an inference guideline would be the choice of mathematical models to estimate the effects of low doses on the basis of high-dose exposures. National Research Council, *Risk Assessment in the Federal Government: Managing the Process* (Washington: National Academy Press; 1983), at 4.

¹³⁰ Dioxin Reassessment Hearing, *supra*, at 64.

¹³¹ *Ibid.*

or that the process followed was inadequate to ensure that Chapter 9 will be a scientifically-based risk characterization.

2. Did EPA Selectively Interpret Scientific Evidence to Exaggerate the Risk of Dioxin?

There is a long history of allegations from interest groups on all sides that the health assessment of dioxin has been dominated more by politics than by science. Interest groups have accused government agencies of either exaggerating or underestimating the risks to human health of exposure to this chemical. Sen. Tom Daschle (D-SD) noted as much in his statement submitted to the hearing record:

"For too long, the process of assessing the health effects of dioxin has been politicized. Charges of government and chemical manufacturer attempts to hide or control scientific information about the harmful effects of dioxin began over a decade ago, and there is much evidence to support those charges."¹³²

His comments reflect views similar to those held by many in the Vietnam veterans' and environmental community. Chairman Rohrabacher reflected the opposite view, that the risks of dioxin have been greatly exaggerated.

Linear vs. Non-Linear Models: Science or Policy?

One of the most frequently cited examples used to demonstrate EPA's systematic exaggeration of risk is its use of linear dose-response models to relate exposure to a toxin to the probability of experiencing adverse health effects.¹³³ There are two common models used to define the relationship between exposure to a toxin (dose) and the probability of experiencing an adverse health effect as a result of that exposure (response). One is a linear model, the other is a non-linear, threshold model.

In the case of the linear model, there is no dose at which a person would not experience an adverse health effect. In the case of the non-linear, threshold model, there are no adverse health effects at low doses, but at some point the

¹³² Testimony of Sen. Tom Daschle submitted to the Dec. 13, 1995 hearing record.

¹³³ Other EPA risk assessment practices have also been criticized as unduly inflating risk estimates. One is the use of high-dose, animal experiments to determine low-dose, human responses. The other is EPA's failure to consider epidemiological studies that indicate no adverse health effects from exposure to toxins. These two issues were raised at the hearing but did not generate as lengthy an exchange between the witnesses. These issues did arise at the SAB review meeting and there were lengthy discussions of these issues as they pertain to the dioxin reassessment. See, *generally*, EPA Science Advisory Board, Transcript of Meeting of Dioxin Health and Exposure Review Panels, May 1995.

amount of the dose reaches a threshold which triggers an adverse effect. The choice of which model to use has significant implications for risk management. If the exact nature of the dose-response curve is unknown (which is usually the case), the use of a linear model results in greater protection from potentially adverse health effects. Therefore, the selection of a dose-response model is a scientific issue that has profound policy implications. Because it is charged with protecting public health and environmental quality, EPA errs on the side of caution and currently uses a linear dose-response model to set regulatory limits for dioxin.

There was an extensive discussion of this topic at this hearing. However, testimony presented at the hearing did little to resolve the issue of which is the most appropriate model. There are gaps in knowledge about the mechanistic biology of dioxin which do not allow either type of model to be definitively selected or ruled out. Critics have claimed that such models are "unproven," and therefore should not be used. Under a standard requiring that human data display the identical relationship between exposure and response displayed by the model, this criticism is valid. Therefore, neither the linear nor the non-linear, threshold model should be used because neither is "proven" for low-level exposures. However, in the area of human health, obtaining empirical proof of harm would present considerable ethical dilemmas. Scientists cannot and would not conduct experiments on humans to derive the precise dose-response relationship because it would require deliberately exposing human subjects, including children, to toxic substances over long time periods. Models are chosen precisely to avoid this type of experimentation. Although the models are not proven that does not mean they are **untested**. Models are continuously re-evaluated as new data become available. The relevant question is not whether a model has been proven, but whether its description of the system is scientifically defensible. Both the linear and non-linear threshold models meet this criteria.

Dr. Gough indicated his belief that a non-linear, dose-response model was more appropriate. He testified that, "...if you consider the biology that is involved in dioxin, it seems inappropriate now to use this model [linear] which associates... a direct relationship between exposure and risk."¹³⁴ The aspect of dioxin biology Dr. Gough refers to is the mediation of dioxin response by a specific receptor in cells, the *Ah* receptor.¹³⁵ However, both Dr. Farland and Dr. Lucier disagreed with Dr. Gough's assertion that a receptor-mediated response indicated that the use of a non-linear, threshold model was more appropriate. They both defended the use of a linear model, citing the fact that dioxin accumulates in human fat tissues which assures that no one receives a zero-level exposure. Dr. Farland explained:

¹³⁴ Dioxin Reassessment Hearing, *supra*, at 65. When a linear model is used, there is no dosage that does not produce a negative effect on human health.

¹³⁵ The *Ah* receptor is a receptor in cells associated with protecting cells from the effects of toxins. Dioxin has been shown to bind to this receptor.

"...our assumption is that because of the biology that is available on dioxin and because we are adding to a background of dioxin that we all carry around,... an incremental exposure to dioxin should be modeled in a linear way, not using a default, but modeled in a linear way."¹³⁶

Dr. Lucier also indicated that, "...receptor modeling doesn't necessarily imply any particular shape to the dose-response curve. No dose-response can be ruled in or out based solely on the knowledge that a response is receptor-mediated."¹³⁷

Dr. Gough stated that his appreciation for Dr. Farland's clarification about the use of a linear model, but he remained unpersuaded and he characterized Dr. Farland's position as exhibiting "an incredible bias." He further indicated, "Most people regard the idea that it's a linear response to be very, very improbable;..."¹³⁸

The SAB report on the dioxin reassessment provided no definitive guidance to the choice of model. Reviewers did indicate that a non-linear, threshold model would also fit the available scientific data, but did not invalidate the EPA's use of a linear model as unscientific. The report noted:

"EPA must describe its analysis in sufficient detail to allow the reader to understand how EPA arrived at its preferred model and how robust those results are - i.e., to what extent would other assumptions be reasonable, adequately fit the data, and lead to different levels of risk.... This is the most important issue in the dose response modeling and should be thoroughly explored in EPA's analysis."¹³⁹

Although in this hearing the debate over linear vs. non-linear threshold models was conducted as a scientific discussion, this debate is a lively one in the regulatory arena as well. As previously stated, the choice of model has substantial policy implications. Dr. Gough noted this in a chapter he co-authored on estimating cancer risks from dioxin:

"Manufacturers, faced with reducing exposures to carcinogens to comply with regulatory limits, would favor the use of threshold models for assessing the risks from nongenotoxic compounds. Similarly, people faced with cleaning up waste sites would welcome the lower risk levels predicted from threshold models. Alternately, people who are convinced of the risk of environmental carcinogens

¹³⁶ Dioxin Reassessment Hearing, *supra*, at 66.

¹³⁷ *Id.* at 67.

¹³⁸ *Id.* at 80.

¹³⁹ SAB Draft Report, p. 76, 77.

are likely to oppose any relaxation of use of the nonthreshold models."¹⁴⁰

The tendency for industry and environmental groups to favor one or the other model has been reported as well:

"Paper and chlorine makers say dioxin has no adverse human health effects below a certain threshold,... Of course environmental groups and some plaintiff's lawyers argue the opposite side of the dioxin issue - that it's dangerous even at low levels of exposure...."¹⁴¹

Others have claimed, as Dr. Gough did in this hearing, that most scientists do not subscribe to the use of a linear model for dioxin. The chemical industry has reportedly tried to portray the acceptance of the non-linear, threshold model as an emerging scientific consensus based upon their characterization of the results of a meeting of dioxin researchers they sponsored in 1990:

"...[T]he Chlorine Institute also said the scientists had agreed that the receptor acts as a sort of biological switch - one that can't be thrown unless dioxin exposure reaches a certain level, or threshold.... The Institute's statements, however, didn't accurately reflect what had happened at the conference. There had been discussion about the possibility... of such a threshold, but no general agreement that one exists.... Subsequent research by Dr. Lucier indicates that for two of three important yardsticks... there is no threshold at all...."¹⁴²

The entire discussion about dose-response models was initiated when Chairman Rohrabacher asked if Dr. Gough had any questions for Dr. Farland.¹⁴³ While everyone can understand the policy argument over the selection of a dose-response model, the scientific argument is difficult for lay persons to follow or participate in. When Dr. Gough had finished with his question about the use of the linear dose-response model, Chairman Rohrabacher said:

¹⁴⁰ Gough, M and Turnbull, D, "Estimating the Cancer Risks of Exposure to 2,3,7,8-Tetrachlorodibenzo-p-Dioxin;" Chapter 7 in Hattermer-Frey, Holly A. and Curtis Travis, Eds., *Health Effects of Municipal Waste Incineration* (Boca Raton, FL: CRC Press; 1991), p. 142.

¹⁴¹ Bailey, Note 125, *supra*.

¹⁴² *Ibid.*

¹⁴³ Dioxin Reassessment Hearing, *supra*, at 64. Dr. Gough responded that he had a couple of questions for Dr. Farland. "I was surprised when you said they were minor,... because one of the criticisms of Chapter 9 is its reliance on the default assumption of a linearized, no-threshold model for carcinogenicity whereas chapters 1 through 7 develop a great deal of information about receptors. And at least a majority of the people on the committee would think that the linearized multistage dose-response model is not appropriate for a receptor-mediated toxic event. And it seems to me that since this is a deviation from long-standing policy within the agency, this is not a minor change."

"Now, the reason why I had Dr. Gough ask that question is because I am sure there are people in the scientific community that understand that question. I don't know how many people on this panel understand it or this committee understand it, but I am sure it's an important question, and we need to make sure that people are on the record on even issues that the committee doesn't understand."¹⁴⁴

What the Chairman's statement illustrates is the difficulty of having Members of Congress preside over a scientific debate. Senator Rockefeller noted as much in a recent Senate hearing on Agent Orange:¹⁴⁵

"...[W]hat I believe even more is that a political forum is particularly ill-suited to analyze the correctness of such scientific undertakings.

"Several years ago, some very learned men urged that we should exercise extreme caution before the Senate should step into such issues; they warned that involving the Senate in Agent Orange decisionmaking would 'place difficult scientific and epidemiological questions in a political forum for resolution at a time when these questions are being revisited in the forum originally intended by the Congress. Irrespective of our individual views on the scientific merits of the case, we believe these are questions the Senate is poorly qualified to resolve.'"¹⁴⁶

As the National Academy of Sciences and other experts in risk assessment have repeatedly noted, the development of risk assessments involves the use of both scientific facts and scientific judgments. The use of models is required to describe the complex system interactions which are the focus of risk assessments because we do not have complete, scientific information. The use of models unquestionably has policy implications, as we saw in this hearing in the debate over linear vs. non-linear, threshold models. The Republican demand for empirical proof requires eliminating the use of assumptions and models since, by definition, they are used when definitive scientific information is lacking. Without such assumptions, it would be impossible to conduct risk assessments. By adhering to a rigid empirical standard while simultaneously insisting that risk assessments be conducted as a precondition for issuing regulations,¹⁴⁷ the

¹⁴⁴ *Ibid.*

¹⁴⁵ Opening Statement of Senator John D. Rockefeller IV, *Implementation of Public Law 102-4: The Agent Orange Act of 1991*, Hearing before Committee on Veterans' Affairs, United States Senate, 104th Cong., 2nd Sess., No. ____ (September 19, 1996).

¹⁴⁶ The quotation used by Sen. Rockefeller is from the Additional Views of Senators Murkowski, Simpson, and Thurmond on the proposed Agent Orange Act, July 24, 1989. S. Rpt. 101-82, p. 60.

¹⁴⁷ H.R. 9 and other regulatory reform proposals considered in the 104th Congress all required the use of risk assessments and cost-benefit analyses by Federal agencies prior to the issuance of regulations.

Republicans have created a definition of "sound science" which would never permit agencies to regulate or demands an approach to human testing our society has judged to be unethical.

EPA and other regulatory agencies have been accused of using "biased" assumptions.¹⁴⁸ However, *all* assumptions have a bias. If an agency chooses a threshold model, it chooses to err on the side of under-regulating and under-protecting. If an agency chooses a linear model, it chooses to err on the side of over-protecting and over-regulating. The question is not whether an agency should use assumptions, but which assumptions it should use. The answer to that question is obviously one that depends on subjective value judgments and policy perspectives, not on science. As Dr. David Ozonoff, one of the reviewers on the SAB health assessment panel, stated:

"...This is a health assessment. Assessment carries with it some implication and connotation of judgment, not just a literature review and , you know, a listing of some people think this and some people think that, on the one hand, but on the other hand.... I'm troubled by the discussion here because people have a variety of ways to interpret this, and I take that as a given.... It's obvious that there's disagreement around this table, and when we talk about the public mis-interpreting what's said in this document, all we have to listen to is the amount of disagreement about interpretation around this table to see that it's not just the public that's got this problem."¹⁴⁹

The hearing revealed no conspiracy on the part of EPA scientists to manipulate scientific information to exaggerate the risk of dioxin. However, the hearing did reveal the policy preference of the EPA versus that of its critics. There are both legitimate scientific debates and policy debates about dioxin, but these should not be confused. Science will never provide all the definitive, detailed knowledge necessary to make the regulatory policy decisions about dioxin a purely objective, scientific one. Members of Congress will continue to have to make these policy choices in an environment of scientific uncertainty.

¹⁴⁸ See, e.g., *The Job Creation and Wage Enhancement Act of 1995*; Report to accompany H.R. 9, Committee on Science, 104th Cong., 1st Sess., H. Rpt. 104-33 (Part II) (Dissenting Views, p. 249): "Statistically unbiased estimates simply do not exist for the models that are generally employed in cancer risk assessment.... Further, as noted by the National Research Council, all assumptions have inherent biases.")

¹⁴⁹ Dr. David Ozonoff, SAB Health Panel, May 1995 meeting.